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Contents

Flora Of Ghaziabad Tehsil In Meerut District*

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The Ghaziabad tehsil situated in north east of Delhi occupies an area of 1140 sq.km. It has an elevation of about 223 m. above sea level. The approximate bearings of Ghaziabad are 28°7′N latitude and 77°12′E longitude. It is bounded by Bulandshahr district and Delhi State in south, by Rohtak district (Haryana State) in west and by tehsils of Bagpat, Meerut and Hapur in north west, north and east respectively.

Ghaziabad is an industrial town and being very close to the capital developing tremendously and the new constructions are followed by the destruction of the natural vegetation.

Topography And Soils

The Ghaziabad tehsil is a part of Indo-Gangetic Plain of northwestern India. It is a level plain with gradual slope from north to south except for some small hilllocks near Loni. The rivers Jamuna and Hindan flow through the area. The Jamuna river makes the boundary of Delhi and Rohtak, while Hindan drains through the western part of the area. These rivers change their course during the rainy season and floods the low lying areas near the villages of Gotra and Loni. A permanent Bundh has been constructed near Loni. The Upper Ganges Canal also passes through the area and two power houses are located on it, one each at Muradnagar and Musoorie. There are several permanent ponds and Jheels which are full of water throughout the year. Of these, jheels of Muradnagar, Dasna and Musoorie are important. A number of temporary ponds, ditches and swamps are also present with rich growth of aquatic and marshy plants.

The soil of the area is rich in plant nutrients except for nitrogen. Three categories of soils can be recognized accordingt o their degree of consistency. They are clayey loam, half sand and half clayey loam and sandy loam. The patches of saline and alkaline soils, locally known as as Reh, Kallar or Usar, are frequently seen near Ghaziabad and Loni.

Climatic Conditions

The climate of Ghaziabad is of semi-arid nature due to low rain fall, high saturation deficit and extremes of temperature. There are three distinct Vegetational seasons : (i) a dry and hot summer season from March to June; (ii) a warm and wet monsoon season from July to September; and (iii) a dry and cool winter season from October to February.

The herbaceous flora is at its zenith during the rainy season. The seeds of these plants germinate with the first showers of the season. They produce flowers and begin to disappear by October. Again, in Winters some herbace-

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ous annuals appear and after flowering they begin to disappear by March. During summers the vegetation is very poor because of high temperature, low humidity and practically no rainfall.

In this part of the country onset of monsoon occurs in the last week of June or first week of July. The normal annual rainfall of Ghaziabad is 600 mm. of which over 80 p.c. takes place during the months of July to September. There are occasional showers from December to February. During last few years there has been great diversities in annual rainfall. It was recorded as much as 1267.94 mm. in 1964 while only 509 mm. in 1965.

Relative humidity is minimum in dry weather months, April and May, and maximum in monsoon months, July to September. During the cold season heavy dew occurs which is of importance to the cold weather annuals.

Temperature shows great extremes during summer and winter. During the months of May, and June the heat is intense and scorching. Sometimes in hot noons of June temperature rises as high as 45°C. Hot winds known as 'Loo' occur in the month of May and June and they exert a very unhealthy and dessicating influence over the vegetation. December and January are the coldest months of year and sometimes temperature reaches the freezing point at night. During the cold season frost is also experienced, which is occasionally so extreme as to injure some crops.

General Character Of The Flora

Permanent Vegetation:—The permanent Vegetation is of xerophytic character due to arid climatic conditions. Trees are rare while the bushy growth is more successful and occupies the greater area. Most of these species flower in late winter or early summer. At this time ground cover is devoid of any herbaceous vegetation.

The most common trees are : **Prosopis juliflora** DC., a native of Mexico and central America, growing very successfully near Moradabad, Ghaziabad, Loni, etc. Other common species are : **Acacia nilotica** (Linn.) Del, **Azadirachta indica** Juss., **Dalbergia sissoo** Roxb., **Diospyros cordifolia** Roxb., **Sterblus asper** Lour., **Syzygium cumini** (Linn.) skeels, and **Tamarindus indica** Linn.

The following species are commonly planted along road sides : **Azadirachta indica** Juss., **Dalbergia sissoo** Roxb., **Kigelia pinnata** DC., **Mangifera indica** Linn., and **Tamarindus indica** Linn.

Among shrubs **Capparis sepiaria** Linn. is most common and abundantly growing in clumps and supporting a number of weak plants. **Adhatoda vesica** Nees. is another dominant species. **Tamarix troupii** Hole and **Tamarix dioica** Roxb. are very common on the sandy banks of Jamuna and Hindan rivers. **Capparis decidua** (Forsk.). Edgew. is quite common in drier parts of the area. Other shrubby species occuring commonly in the area are : **Acacia rugata** (Lamk) Ham, **Butea monosperma** Taub., **Carissa spinarum** Linn., **Flacourtia indica** (Burm. f.) Merr., **Helicteres isora** Linn., and **Zizypyhus nummularia** Wt. & Arn.

Some woody climbers, such as, **Abrus precatorius** Linn., **Capparis zeylanica** Linn. non Hook. f. & Thoms., **Ichnocarpus**

frutescens R. Br., **Leptadenia reticulata** Wt. & Arn., and **Zizyphus oenoplia** Mill. occur commonly in the area climbing on trees and shrubs.

Typha angustata Bory & Chaub., a perennial shrub, is very common in marshes and swamps. The following perennial grasses also occur permanently in the area : **Arundo donax** Linn., **Cynodon dactylon** Pers., **Desmostachya bipinnata** Stapf., **Phragmites karka** Trin., **Sachharum munja** Linn., **Sorghum halepenese** (Linn.) Pers., and **Vetiveria zizanoides** (Linn.) Nash.

The following perennial species are also commonly met within the area, occurring all the year round : **Abutilon asiaticum** G. Don., **Abutilon indicum** Sweet, **Calotropis procera** R. Br., **Hibiscus vitifolius** Linn., **Hibiscus mircanthus** Linn., **Pluchea lanceolata** Cl. **Sida rhombifolia** Linn., and **Urena lobata** Linn.

Ephemeral Vegetation :— With the first showers of monsoon seeds of a large variety of weeds begin to germinate and soon they cover the surface forming a green carpet of temporary vegetation. Most of these species flower and fruit in August-September and begin to disappear by October-November. A number of weeds again appear in cold season and they persist till about March. Some annual herbs also appear in March/Aprial and they grow successfully in unused grounds and field. They persist till the arrival of monsoon or up to the monsoon period.

The most common annuals of the rainy season belong to the families Capparidaceae, Tiliaceae, Papilionaceae, Caesalpinaceae, Rubiaceae, Compositae, Convolvulaceae, Pedaliaceae, Labiatae, Amaranthaceae, Euphorbiaceae, cyperaceae and Grmineae. Thefollowing are the common weeds of rainy season : **Achyranthes aspera** Linn., **Apluda mutica** Linn., **Artemisia scoparia** Waldst. & Kit., **Bidena biternata** Merr. & Sherff, **Borreria stricta** (Linn. f.) K. Schum., **Borreria articularis** (Linn. f.) F. N. Will., **Bothriochloa pertusa** (Linn.) A. Camus, **Bulbostylis barbata** Cl., **Cassia occidentalis** Linn., **Cassia obtusifolia** Linn., **Ceolosia argentea** Linn., **Cleome visosa** Linn., **Corchorus** spp., **Crotalaria medicaginea** Lamk., **Croton bonplandianum** Baill. **Cyperus rotundus** Linn., **Eragrostis tremula** Hochst., **Digera alternifolia** Aschers, **Euphorbia hirta** Linn., **Euphorbia prostrata** Ait., **Cleome gynandra** Linn., **Heliotorpium strigosum** Willd., **Heteropogon contortus** (Linn.) R. & S., **Indigofera linifolia** Heyne., **Indigofera linnaei** Ali, **Cyperus kvllingea** Endl., **Leucas aspera** Spreng., **Leucas cephalotes** Spreng., **Oldenlandia corymbosa** Linn., **Phyllanthus fraternus** Webster, **Polycarpaea corymbosa** Lamk., **Portulaca oleracea** Linn., **Sporobolus dianper** Beauv., **Triumfetta rhomboidea** Jacq., **Trianthema portulacastrum** Linn. **Vicoa indica** (Willd.) DC.

The following climbers and twiners are also commonly met with during rainy season. **Cardiospermnm halicacabum** Linn., **Coccinea cordifolia** Cogn., **Dolichos biflorus** Linn., **Ipomoea eriocarpa** R. Br., **Melothria maderaspatana** Cogn., **Rhynochosia minima** DC. and **Trichosanthes cucumerina** Linn.

The common weeds associated with paddy fields are : **Aeschynomene indica** Linn., **Ammania baccifera** Linn, **Echinochloa crus-galli** Beauv., **Dopatrium junceum** Buch.-Ham.

Eriocaulon sieboldianum Sieb., **Hydrolea zeylanica** Vahl., **Monochoria vaginalis** Presl., **Sagittaria guayanensis** H. B. & K. and **Sphenoclea zeylanica** Gaertn.

The common weeds of winter season are: **Anagallis arvensis** Linn., **Antirrhinum orontium** Linn., **Arenaria serpyllifolia** Linn., **Argemone mexicana** Linn., **Asphodelus tenuifolius** Cav., **Convolvulus arvensis** Linn., **Coronopus didymus** Sm., **Gnaphalium indicum** Linn., **Fumaria indica** Pugsley. **Lathyrus aphaca** Linn., **Lathyrus sativa** Linn., **Mazus japonicus** Kuntze, **Medicago polymorpha** Linn., **Medicago lupulina** Linn., **Melilotus alba** Desr., **Melilotus indica** All, **Oxalis corniculata** Linn., **Poa annua** Linn., **Polypogon monspelensis** Desf., **Rumex dentatus** Linn., **Rugia pectinata** (Linn.) Nees, **Sonchus oleraceus** Linn., **Spergula arvensis** Linn., **Stellaria media** Cyrill., **Vaccaria pyramidata** Medik., **Veronica anagallisaquatica** Linn., and **Vicia sativa** Linn.

The following are some common weeds which appear in March/April : **Alhagi pseudoalhagi** Desy., **Alternathera pungens** H. B. & K., **Carthamns oxyacantha** Bieb., **Gomphrena celosioides** Mart., **Heliotropium eichwaldii** Steud., **Hemigraphis hirta** T. Anders. and **Echinops echinatus** Roxb.

The common species occurring on waste lands are as follows : **Amaranthus spinosus** Linn., **Blumea lacera** DC., **Calotropis procera** R. Br., **Cannabis sativa** Linn., **Cassia obtusifolia** Linn., **Chenopodium ambrosioides** Linn., **Croton bonplandianum** Baill., **Solanum surattense** Burm. f. and **Xanthium strumarium** Linn.

The following are some common species occurring in dry sandy localities : **Aerua javanica** (Burm. f.) Spreng, **Alhagi pseudoalhagi** Desv., **Arnebia hispidissima** DC., **Crotalaria burhia** Buch.- Ham., **Eragrostis tremula** Hochst., **Heliotropium strigosum** Willd., **Indigofera cordifolia** He yneex Roth, **Lepidagathis hamiltoniana** Wall., **Perotis indica** (Linn.) O. Kuntze, **Tribulus terrestris** Linn. and **Zornia gibbosa** Spanoghe.

Cressa cretica Linn., **Salsola baryosma** (R. & S.) Dandy and **Suaeda maritima** (Linn.) Dumort are most common species inhabiting saline and alkaline lands.

Blumea lacera DC., **Chloris inflata** Link., **Kickxia ramosissima** (Wall.) Janchen, **Lindenbergia urticaefolia** Link & Otto. **Nepeta hindostana** (Roth,) Haines, **Vernonia cinerea** (Linn.) Less. and seedlings of **Ficus** spp. are some characteristic members which inhabit crevices of walls of old buildings.

The parasitic species occurring in the area include : **Cuscuta reflexa** Roxb., **Dendropthoe falcata** (Linn. f.) Ettings, **Orobanche aegytpiaca** Pers. and **Striga euphrasioides** Benth.

Aquatic and Marshy Vegetation : The area is quite rich in aquatic and swampy Vegetation because of the presence of several permanent ponds and jheels. There are also a large number of temporary ponds and ditches which show a rich growth of hydrophytes during rainy season. There is a wide area of low land which floods during rainy season. The banks of rivers and canals are also rich in marshy vegetation.

The submerged aquatic species are repre-

sentded by : **Ceratophyllum demersum** Linn., **Hyrilla verticallata** Royle, **Najas, graminea** Del., **Potamogeton crispus** Linn , **Vallisneria spiralis** Linn. and **Zannichellia palustris** Linn.

The common free floating aquatic species are : **Eichhornia crassipes** Solms., **Lemna paucicostata** Hegel., **Spirodela polyrrhiza** Schleid., **Trapa natans** Linn. var. **bispinosa** (Roxb.) Makino, **Utricularia stellaris** Linn. f. and **Wolffia microscopica** Kurz.

The attached floating those include : **Aponogeton natans** (Linn.) Engl. & Krausse **Nymphaea nouchali** Burm. f., **Nymphaea stellata** Willd., **Potamogeton indicus** Roxb. and **Sagittaria guayanensis** H. B. & K.

The common species which inhabit marshes are : **Arundo donax** Linn., **Caesulia axillaris** Roxb., **Cyperus iria** Linn., **Echinochloa crusgalli** Beauv., **Fimbristylis** spp., **Ipomoea aquatica** Forsk., **Juncellus** spp., **Ranunculus sceleratus** Linn., **Scirpus** spp. and **Sphenoclea zeylanica** Gaertn.

Besides these there are a large number of moist loving species which grow near water edges and show hydrophvtic characters. Common among them are : **Alternanthera sessillis** R. Br., **Ageratum conyzoides** Linn. **Ammania baccifera** Linn., **Bacopa monnieri** (Linn.) Pennell., **Centella asiatica** (Linn.) Urban, **Cyanotis axillaris** Schult. f., **Eclipta prostrata** (Linn.) Linn., **Hydrolea zeylanica** Vahl., **Jussiaea perennis** (Linn.) Brenan **Mentha piperita** Linn., **Phyla nodiflora** (Linn.) Green., **Polygonum** spp., **Rumex dentatus** Linn,, **Salvia plebia** R. Br. and **Veronica anagallisaquatica** Linn.

Conclusion

From Ghaziabad tehsil 620 species of Angiosperms representing 396 genera and distributed over 107 families have been collected. Out of 620 species collected 414 species are indigenous or naturalized. Of the 126 species of Monocotyledons 88 belong to the Cyperaceae and Gramineae, while the remaining 38 species belong to 21 different families. Table I gives the total number and percentage of families, genera and species belonging to Dicotyledones and Monocotyledones.

TABLE I

	Dicotyledones		Monocotyledones	
	Total Number	Percentage	Total Number	Percentage
Families	84	78.5	23	21.5
Genera	317	75.3	79	24.7
Species	494	74.4	126	24.4

The nine dominant families according to mere number of species are in the order given in Table II.

TABLE II

S. No.	Name of Family	No. of genera	No. of species
1.	Papilionaceae	33	64
2.	Gramineae	40	61
3.	Compositae	26	32
4.	Cyperaceae	7	27
5.	Malvaceae	9	22
6.	Acanthaceae	13	21
7.	Cucurbitaceae	10	19
8.	Euphorbiaceae	9	18
9.	Scrophulariaceae	11	15

Enumeration of the Species

The order of families in the list given in the following pages is the same as that of Duthie (1903-1929) in the Flora of the Upper Gangetic Plain. Hutchinson (1959) has been followed in splitting of families. An attempt has been made to bring nomenclature up to date as far as possible. Only important synonyms are given. The plants marked with as asterisk (*) have not been recorded by Duthie in the Flora of the Upper Gangetic Plain.

Class I Dicotyledones

Sub-class I Polypetalae

Ranunculaceae
Ranunculus Sceleratus Linn.

Annonaceae
Annona souamosa Linn.

Polyalthea longifolia Thw.
Artobotrys odoratissima R. Br.

Menispermaceae
Cocculs hirsutus (Linn.) Diels.

(=**C.Villosus** DC.)
Cissampelos pareira Linn.

Nymphaeaceae
Nymphaea nochali Burm. f.
(=**N. lotus** Linn.)
Nymphaea stellata Willd,
Nelumbo nucifera Gaertn.
(=**Nelumbium speciosum** Willd.)

Papaveraceae
Argemone mexicana Linn.

Fumariaceae
Fumaria indica (Haussk.) Pugsley
(=**F. Parviflora** Lamk.)

Cruciferae
Rorippa montana Small.
(=**Nasturtium montanum** Wall.)
Brassica juncea Hook. f. & Th.
Brassica campestris Linn. var. **sarson** Prain.
Brassica rapa Linn.
Brassica oleraceae Linn. var. **capitata** Linn.
Brassica oleracea Linn. var. **botrytis** Linn.
Brassica oleracea Linn. var. **caularapa** D.C.
Eruca sativa Mill:
Coronopous didymus (Linn.) Sm.
(≡**Senebiera pinnatifida** DC.)
Lepidium sativum Linn.
Raphanus sativus Linn.

Capparidaceae
Cleome gynandra Linn.
(≡**Gynandropsis gynandra** (Linn.) Briq)
Capparis decidna (Forsk.) Edgw.
(=**C. aphylla** Roth.)
Capparis sepiaria Linn.
Capparis zevlanica Linn. non Hook. f. & Th.
(=**C. horrida** Linn.)

Flacourtiaceae
Flacourtia indica (Burm. f.) Merr.
(=**F.ramontchi** L'Herit)

Polygalaceae
Polygala chinensis Linn.

Caryophyllaceae
Vaccaria pyramidata Medik.
(=**Saponaria vaccaria** Linn.)
Silene conoidea Linn.
Stellaria media Cyrill.
Arenaria serpyllifolia Linn.
Spergula arvensis Linn.
Polycarpaea corymbosa (Linn.) Lamk.

Portulacaceae
Portulaca oleracea Linn.
portulaca quadrifida Linn.

Tamaricaceae
***Tamarix troupii** Hole
(=**T. gallica** auct. (non Linn.)
Tamarix dioica Roxb.

Malvaceae
Malva parviflora Linn
Malvastrum coromandalianum (Linn.) Garcke.
(=**M. tricuspidatum** A. Gray)
Sida alba Linn.
(=**Sida spinosa** Linn.)
Sida acuta Burm. f.
Sida rhombifolia Linn.
Sida cordifolia Linn.
Abutilon asiaticum G. Don.
Abutilon indicum Sweet.
Abutilon graveolens W.&A.
Urena lobata Linn.

Hibiscus micranthus Linn. f.
Hibiscus lobatus (**Murr.**) Kuntze.
(=**H. solandra** L'Herit)
Hibiscus vitifolia Linn.
Hibiscus cannabinus Linn.
Hibiscus mutabilis Linn.
Hibiscus rosa-sinensis Linn.
Hibiscus syriacus Linn.
Malvaviscus conzatti Greenm.
Abelmoschus moschatus Medic.
(=**Hibiscus abelmoschus** Linn.
Abelmoschus esculentus (Linn.) Moench.
(=**Hibiscus esculentus** Linn.)
Gossypium spp.

Bombacaceae

Salmalia malabarica (DC.) Schott & Endl.

Sterculiaceae

Helicteres isora Linn.
Waltheria indica Linn.
Melochia corchorifolia Linn.
Pterygota alata (Roxb.) R.Br,
(=**Sterculia alata** Roxb.

Tiliaceae

Grewia asiatca Linn.
Grewia sapida Roxb.
Triumfetta bartramia Linn.
(=**T. rhomboidea** Jacq.
Corchorus capsularis Linn.
Corchorus olitorius Linn.
Corchorus trilocularis Linn.
Corchorus tridens Linn.
Corchorus aestuans Linn.
(=**C. acutangulus** Lamk.)

Linaceae

Linum usitatissimum Linn.

Zygophyllaceae

Tribulus terrestris Linn.

Oxalidaceae

Oxalis corniculata Linn.
***Oxalis intermedia** A. Rich.
(=**O. latifolia** auct. non H.B.&K)
***Oxalis maritima** Zucc.
(=**O. corymbosa** DC.)
Averrhova carambola Linn.

Rutaceae

Murraya paniculata (Linn.) Jacq.
(=**M. exotica** Linn.)
Citrus medica Linn.
Citrus aurantium Linn.
Aegle marmelos Correa.

Simaroubaceae

Alianthus excelsa Roxb,

Meliaceae

Toona ciliata Roem,
(=**Cedrella toona** Roxb.)
Azadirachta indica A. Juss.
(=**Melia azadirachta** Linn.)
Melia azedarach Linn.

Rhamnaceae

Zizyphus mauritiana Lamk.
(=**Z. Jujuba** Lamk.)
Zizyphus nummularia Burm. f.) W.&A.
(=**Z. rotundifolia** Lamk.)
Zizyphus oenoplis Mill.

Vitaceae

Vitis vinifera Linn.
Ampelocissus latifolia (Roxb.) Planch.
(=**Vitis latifolia** Roxb.)
Cayratia carnosa Gagnep.
(=**Vitis trifolia** Linn.)

Sapindaceae

Cardiospermum halicacabum Linn.

Dodonaea viscosa (Linn.) Jacq.
Litchi chinensis Sonner.
(=**Nephalium litchi** Camb.)

Anacardiaceae

Mangifera indica Linn.

Moringaceae

Moringa oleifera Lamk.
(=**M. pterygosperma** gaertn.)

Papilionaceae

Crotalaria alata Buch.-Ham.
Crotalaria burhia Buch.-Ham
Crotalaria prostrate Rottl.
Crotalaria calycina Schrank.
Crotalaria mysorensis Roth.
Crotalaria sericea Retz.
Crotalaria juncea Linn.
Crotalaria medicaginea Lamk. var. **neglecta** Baker.
Crotalaria medicaginea Lamk. var. **luxurians** Baker
Trifolium alaxandrum Linn.
Melilotus indica All.
Melilotus alba Desr.
Trigonella hamosa Linn.
Trigonella foenum-graceum Linn.
Medicago lupulina Linn.
Medicago sativa Linn.
Medicago polymorpha Linn.
(=**M. denticulata** Willd.)
Atylosia scrabaeoides Benth.
Cajanus cajan (Linn.) Millsp
(=**C. indicus** Spreng.)
***Rhynchosia minima** (Linn.) DC. var. **laxiflora** Baker.
Rhynchosia capitata DC.
(=**R. aurea** DC.)
Phaseolus aconitifolius Jacq.
Phaseolus radiatus Linn.
Phaseolus mungo Linn.
Vigna sinensis (Linn.) Savi
(=**V. catiang** Wolf.)
Dolichos lablab Linn.
Dolichos biflorus Linn.
Clitoria ternatea Linn.
Teramnus labialis (Linn.f.) Spreng.
Mucuna pruriens DC.
Butea monosperma (Lamk.) O. Ktz.
(=**B. frondosa** Roxb.)
Sesbania sesban (Linn.) Merr. var. **sesban**
Sesbania sesban (Linn.) Merr. var. **bicolour**, W. & A.
Sesbania bispinosa (Jacq.) W.F. Wight
(=**S. aculeata** Pers.)
Tephrosia strigosa (Dalz.) Santapau & Mahesh.
(=**T. tenuis** Wall.)
Tephrosia pnrpurea (Linn) Pers.
Cyamopsis tetragonolobus (Linn.) Taub.
(=**C. psoralioides** DC.)
Indigofera linifolia Retz.
Indigofera linnaei Ali
(=**I. enneaphylla** Linn.)
Indigofera cordifolia Heyne ex Roth.
Indigofera glabra Linn.
Indigofera hirsuta Linn.
Indigofera tinctoria Linn.
Cicer arietinum Linn.
Lens culinaris Medik.
(=**L. esculenta** Moench.)
Vicia hersuta S. F. Gray
Vicia Sativa Linn.
Vicia faba Linn.
Lathyrus aphaca Linn.
Lathyrus Sativa Linn.
Pisum arvense Linn.
Pisum Sativum Linn.
Abrus precatorius Linn.
Dalbergia sissoo Roxb.
Zornia gibbosa Spanoghe.

(=**Z. Diphylla** Pers.)
Aeschynomene Indica Linn.
Uraria picta Desv.
Alysicarpus monilifer D. C.
Alysicarpus vaginalis D. C.
Alysicarpus rugosus D. C, var. **heyneanus** Baker.
Alysicarpus rugosus D. C. var **minor** Prain
Alysicarpus tetragonolobus Edgew.
Alhagi pseudoalhagi (Bieb.) Desv.
(=**A. camelorum** Fisch.)
Desmodium triflorum (Linn.) D. C.
Desmodium gangeticum (Linn. D. C.)
Arachis hypogea Linn.

Caesalpinaceae

Cassia fistula Linn.
Cassia javanica Linn.
Cassia occidentalis Linn.
Cassia sophera Linn.
Cassia obtusifolia Linn.
Cassia absus Linn.
Bauhinia variegata Linn.
Bauhinia purpurea Linn.
Bauhinia acuminata Linn.
Tamarindus indica Linn.
Delonix regia (Boj.) Raf.
(=**Poinciana regia** Boj)
Poinciana pulcherrima Linn.
(=**Caesalpinia pulcherrima** Sw.)

Mimosaceae

Mimosa pudica Linn.
Acacia farnesiana (Linn.) Willd,
Acacia nilotica (Linn.) Del. subsp. **indica**. (Benth.) Brenan
(=**A. arabica** Willd.)
Acacia leucophloea (Roxb.) Willd.
Acacia catechu Willd·
Acacia rugata (Lamk.) Ham.
(=**Acacia concinna** DC.)
Albizzia lebbek Benth.
Pithecolobium dnlce Benth.
Leucaena leucocephala (Lamk.) Wt.
(=**L. glauca** Benth.)
Prosopis juliflora (Sw.) DC.

Rosaceae

Prunus persica (Linn.) Stokes
Prunus domestica Linn.subsp. **insititia** (Linn.) Schneid.
(=**P.communis** Huds, var. **insititia** Hook.f)
Potentilla supina Linn.
Rosa spp.
Eriobotrya japonlca (Thunb.) Lindl.

Combretaceae

Terminalia bellerica (Gaertn) Roxb.
Terminalia arjuna (Roxb. ex DC.) W. & A.
(**T. glabra** W. & A.)
Quisqualis indica Linn.

Myrtaceae

Callistemon lanceolatus DC.
Syzygium cumini (Linn.) Skeels
(=**Eugenia jambolina** Lamk.)
Syzygium cumini (.Linn.) Skeels var. **microcarpa** Thw.)
(=**Eugenia jambolina** Lamk. var **microcarpa** Thw:)
Eucalyptus citriodora Hook.
Psidium guajava Linn.

Lythraceae

Ammania baccifera Linn.
Ammania salicifolia Monti.
Ammania senegalensis Lamk.
Lawsonia inermis Linn.
(=**L. alba** Lamk.)
Lagerstroemia indica Linn.

Punicaceae

Punica granatum Linn.

Onagraceae

Jussiaea repens Linn.
Jussiaea suffructicosa Linn.
Jussiaea perennis (Linn.) Brenan.
(= **Ludwigia parviflora** Roxb.)

Trapaceae

Trapa natans Linn. var. **bispinosa** (Roxb.) Makino
(= **T. bispinosa** Roxb.)

Caricaceae

Carica papaya Linn.

Cucurbitaceae

Trichosanthes cucumerina Linn.
Trichosanthes dioica Roxb.
Lagenaria leucantha (Duch.) Rusby.
(= **L. vulgaris** Ser.)
Luffa acutangula (Linn.) Roxb.
Lulla cylindrica (Linn.) M.V. Roem.
(= **L. aegyptiaca** Mill.)
Benincasa hispida (Thunb.) Cogn.
Momordica charantia Linn.
Cucumis melo Linn.
Cucumis melo Linn. var. **momordica** Duthie & Fuller.
Cucumis melo Linn. var. **utilissimus** Duthie & Fuller
Cucumis sativus Linn.
Citrullus vulgaris Schrad.
Citrullus vulgaris Schrad. var. **fistulosus** Duthie & Fuller.
Cucurbita moschata Duch. ex. Poir.
Cucurbita maxima Duch.
Cucurbita pepo Linn.
Coccinia cordifolia (Linn) Cogn.
(= **C. indica** W.&A.)
Melothria perpusilla Cogn.
Melothria maderaspatana (Linn.) Cogn.

Cacataceae

Opuntia elatior Mill.
(= **O. dillenii** Haw.)

Aizoaceae

Trianthema portulacastrum Linn.
(= **T. monogyna** Linn.)
Trianthema crystallina Vahl.
Trianthema govindia Buch. Ham. ex G. Don
(= **T. pentandra** Linn.

Molluginaceae

Glinus lotoides Linn.
(= **Mollugo hirta** Thunb.)
Mollugo pentaphylla Linn.
Mollugo cerviana Ser.
Mollugo nudicaulis Lamk.
Gisekia pharnaceoides Linn.

Umbelliferae

Centella asiatica (Linn.) Urban.
(= **Hydrocotyle asiatica** Linn.)
Trachyspermum ammi Linn. Sprangue
(= **Carum copticum** Benth. & Hook. f.)
Foeniculum vulgare Mill.
Anethum graveolens Linn.
(= **Pucedanum graveolens** Benth. & Hook. f.).
Coriandrum sativum Linn.
Cuminum cyminum Linn.
Daucas carota Linn.

Sub-Class II Gamopetalae

Rubiaceae

Mitragyna parvifolia (Roxb.) Korth
Oldenlandia corymbosa Linn.
Ixora coccinea Linn.
Borreria stricta (Linn. f.) K. Schum.
(= **Spermacoce stricta** Linn. f.)
Borreria articularis (Linn. f.) F. N. will
(= **Spermacoce hispida** Linn.)
Mussaenda luteola Delile

Compositae

Vernonia cinerea (Linn.) Less.
Ageratum conyzoides Linn.
Grangea maderaspatana (Linn.) Poir.
Erigeron canadensis Linn.
Erigeron bonariendis Linn.
(=**E. linifolius** Willd.)
Blumea lacera (Burm.f.) DC.
Pluchea lanceolata C.B. Clarke.
Sphaeranthus indicus Linn.
Gnaphalium luteo-album Linn.
Gnaphalium indicum Linn.
Caesulia axillaris Roxb.
Vicoa indica (Willd.) DC.
(=**Inula indica** Willd.)
Vicoa vestita Benth. ex Hook. f.
(=**Inula vestita** Wall.)
Pulicaria crispa Schu.-Bip.
Xanthium strumarium Linn.
Eclipta prostrata (Linn.) Linn.
(=**E. erecta** Linn.)
Blainvillea latifolia (Linn. f.) DC.
(=**B. rhomboidea** Cass.)
Bidens biternata Merr. & Sherff.
(=**B. pilosa** auct. (non. Linn.)
Tridax procombens Linn.
Cotula anthemoides Linn.
Artemisia scoparia Waldst. & Kit.
Emilia sonchifolia DC.
Echinops echinatus. Roxb.
Saussurea candicans C.B. Clarke
Volutarella ramosa (Roxb.) Santapau
(=**V. divaricata** Benth. & Hook. f.)
Lactuca sativa Linn,
Lactuca runcinata DC.
Sonchus asper. (Linn.) Hill
Sonchus oleracens Linn.
Launaea asplenifolia Hook. f,
Launaea nudicaulis Hook. f.
***Carthamus oxacantha** Bieb.

Sphenocleaceae

Sphenoclea zeylancia Gaertn

Plumbaginaceae

Plumbago zeylanica Linn.

Primulaceae

Anagallis arvensis Linn.

Sapotaceae

Manilkara hexandra (Roxb.) Dub.
(=**Mimusops hexandra** Roxb.)
Mimusops elengi Linn.

Ebenaceae

Diospyros cordifolia Roxb.

Oleaceae

Jasminum multiflornm (Burm.f.) Andr,
(=**J. pubescens** Willd.)
Jasminum sambac (Linn.) Ait.
Jasminum humile Linn.
Jasminum offiicinale Linn.

Apocynaceae

Carissa congesta Wight.
(=**C. carandas** Linn.)
Carissa spinarum Linn.
Catharanthus pusillus (Murr.) G. Don
(=**Vinca pusilla** Murr.)
Tabernamontana divaricata (Linn.) R.Br.
(=**Eravatamia coronaria** Stapf.)
Nerium indicum Mill.
(=**N. odorum** Soland.)
Ichnocarpus frutescens R. Br.
Thevetia peruviana (Pers.) Merr.
(=**T. nerifolia** Juss. ex. Steud.)
Plumeria rubra Linn. forma **acuminata** Santapau & Irani ex Shah
(=**P. acutifolia** Poir)
Beaumontia grandiflora Wall.

Asclepiadaceae

Calotropis gigantea R. Br.
Calotropis procera R. Br.
Pentatropis spiralis (Forsk.) Decne
(=**P. cynanchoides** R. Br.)
Dregea volubilis Benth. ex Hook. f.
(=**Marsdenia volubilis** T. Cooke.)
Pergularia daemia (Forsk.) Blatt. & McCan
(=**Daemia extensa** R.Br.)
Leptadenia reticulata Wt. & Arn.
Leptadenia pyrotechnica (Forsk.) Decne
(=**L. spartium** Wt.)
Ceropegia bulbosa Roxb.

Loganiaceae

Buddleia asiatica Lour.

Gentianaceae

Enicostema verticillatum Engl.
(=**E. littorale** Blume)
Centaurium roxburghii (G. Don) Druce
(=**Erythrea roxburghii** G. Don)

Hydrophyllaceae

Hydrolea zeylanica (Linn.) Vahl.

Boraginaceae

Heliotropium eichwaldi Steud. ex DC.
Heliotropium strigosum Willd.
Trichodesma indicum R.Br.
Cynoglossum lanceolata Forsk.
Arnebia hispidissima (Lehm.) DC.

Ehretiaceae

Cordia dichotoma Forst. f.
(=**C. myxa** Linn.)
Ehretia laevis Roxb.

Convolvulaceae

Porana paniculata Roxb.
Cressa cretica Linn.
Evolvulus alsinoides Linn.
***Volvulopsis nnmmularia** (Linn.) Roberty.
(=**Evolvulus nummularius** Linn.)
Convolvuls microphyllus Sieb ex Spreng.
(=**C. pluricaulis** Choisy)
Convolvulus arvensis Linn.
Ipomoea eriocaroa R.Br.
(=**I. hispida** (Vahl.) (R. & S.)
Ipornoea sindica Stapf.
Ipomoea pilosa Sweet.
Ipomoea reptans (Linn.) Poir.
(=**I. aquatica** Forsk.)
Ipomea maxima (Linn.f.) Don ex Sweet.
(=**I. sepiaria** Koenig ex Sweet)
Ipomea obscura (Linn.) Ker-Gawl.
Ipomea nil (Linn) Roth
(=**I. hederacea** Jacq.)
Ipomoea pestigridis Linn.
Ipomoea fistulosa Mart. ex Choisy
(=**I. carnea auct.** (non Jacq.)
Ipomoea batatas Lamk.
Ipomoea carica (Linn.) Sweet
(=**I. palmata** Forsk.)
Ipomoeo purpurea Linn.
Ipomoea angulata Lamk.
(=**I. coccinea** Cl.)
Ipomoea muricata Jacq.
(=**Calonyction muricatum** G. Don)
Rivea hypocrateriformis Choisy

Cuscutaceae

Cuscuta reflexa Roxb.

Solanaceae

Solanum nigrum Linn.
Solanum surattense Burm. f.
(=**S. xanthocarpum** Schrad. & Wendl.)
Solanum indicum Linn.

***Solanum torvum** Sw.
Solanum melongena Linn.
Solanum tuberosum Linn.
Lycopersicon esculentum Mill.
(=**Solanum lycopersicum** Linn.)
Physalis minima Linn.
Withania somnifera (Linn.) Dunal
***Nicotiana plumbaginifolia** Viv.
Nicotiana tabacum Linn.
Lycium europaeum Linn.
Datura stramonium Linn.
Capsicum annuum Linn.
Cestrum nocturnum Linn.

Scrophulariaceae

Verbascum chinense (Linn.) Santapau
(=**Celsia coromandeliana** Vahl)
Kickxia ramosissima (Wall.) Janchen
(=**Linaria ramosissima** Wall.)
Antirrhinum orontium Linn.
Bacopia monnieri (Linn.) Pennell
(=**Moniera cuneifolia** Michx.)
Mazus japonicus (Thunb.) Kuntze
(=**M. rugosus** Lour.)
Dopatrium junceum Buch-Ham.
Lindernia crustacea [Linn.] F. Muell.
(=**Vandellia crustacea** Benth.)
Lindernia multiflora F. Muell.
[=**Vandellia multiflora** G. Don.]
Lindernia ciliate [Colsm.] Pennell
(=**Bonnaya brachiata** Link & Otto)
Scoparia dulce Linn.
Veronica anagallis-aquatica Linn.
Veronica agrestis Linn.
Striga euphrasioides (Vahl.) Benth.
Lindenbergia indica (Linn.) Kuntze
(=**L. urticaefolia** Lehm.)

Orobanchaceae

Orobanche aegyptiaca Pers.

Lentibulariaceae

Utricularia stellaris Linn. f.

Bignoniaceae

Kigelia pinnata DC.
Tecoma stans (Linn.) H.B. & K.
Haplophragma adenophyllum (Wall.) G. Don.
(=**Heterophragma adenophyllum** Seem. ex Benth. & Hook.
Jacranda mimosifolia D. Don
Pyrostegia venusta (Ker Gawl.) Miers.
(=**Bignonia venusta** Ker-Gawl.)
Campsis radicans (Linn.) Seem.

Pedaliaceae

Sesamum indicum Linn.
***Pedalium murex** Linn.

Martyniaceae

Martynia annua Linn.
(=**M. diandra** Glox)

Acanthaceae

Thunbergia grandiflora (Roxb. ex Rottl.) Roxb.
Elytraria acaulis (Linn.f.) Lindau
(=**Tubiflora acaulis** Kuntze)
Blepharis maderaspatensis (Linn.) Heyne ex Roth.
(=**B. boerhaviaefolia** Pers.)
Blepharis molluginifolia Pers.
Hygrophila auriculata (Schumach) Heine
(=**Asteracantha longifolia** (Linn.) Nees)
Hygrophila polysperma (Roxb.) T.Anders.
Dipteracanthus prostratus (Poir.) Nees
(**Ruellia prostrata** Lamk. var. **dejecta** Cl.)
Hemigraphis hirta T. Anders.
Andrographis paniculata Nees
Andrographis echioides Nees
Barleria prionitis Linn.

Barleria cristata Linn.
Lepidagathis hamiltoniana Willd.
Justicia quinqueangularis Koen. ex Roxb.
Justicia diffusa Willd.
Justicia simplex D. Don
Justicia gendarussa Burm. f.
Peristrophe bicalyculata (Retz.) Nees
Rungia repens Nees
Rungia pectinata (Linn.) Nees
(=**R. parviflora** Nees var, **pectinata** Cl.)

Verbenaceae

Lantana carmara Linn. var. **aculeate** (Linn.) Moldenke
(=**L. Camara** auct. (non Linn.).
Phyla nodiflora (Linn.) Greene
(=**Lippia nodiflora** A Rich.
Verbena officinalis Linn.
Vitex negundo Linn.
Clerodendrum phlomidis Linn. f.
Clerodendrum indicum (Linn.) Kuntze
(=**C. siphonanthus** R.Br.)
Clerodendrum inerme (Linn.) Gaertn.
Duranta repens Linn.
(=**D. plumieri** Jacq.)
Petrea volubilis Linn.
Nyctanthes arbortristis Linn.

Labiatae

Ocimum sanctum Linn.
Ocimum americanum Linn.
(=**O. canum** Sims)
Ocimum basilicum Linn.
Anisomeles indica (Linn.) Kuntze
(=**A. ovata** R. Br.)
Leucas urticaefolia R. Br.
Leucas aspera (Willd.) Spreng.
Leucas linifolia Spreng.
Leucas cephalotes Spreng.
Leucas nutans Spreng.
Nepeta hindostana (Roth) Haines
(=**N. ruderolis** Buch-Ham. ex Hook. f.)
Salvia plebeia R.Br.
***Mentha piperita** Linn.
Mentha spicata Linn.
(=**M. viridis** Linn.)

Subclass III Monochlamydeae

Nyctaginaceae

Boerhavia diffusa Linn.
Boerhaavia chinensis (Burm.f.) Druce
(=**B. repanda** Willd.)
Mirabilis jalapa Linn.
Bougainvillea spectabilis willd.
Bongainvillea glabra Choisy

Amaranthaceae

Celosia argentea Linn.
Digera alternifolia (Linn) Aschers.
(=**D. arvensis** Forsk.)
Amaranthus spinosus Linn.
Amaranthus blitum Linn. var. **Oleracea** Hook. f.
Amaranthus gracilis Desf.
(=**A. viridis** Linn.)
Amaranthus tricolor Linn.
(=**A. polygamous** Linn.)
Aerua tomentosa Forsk.
(=**A. javanica** Juss.)
Aerua lanata (Linn.) Juss.
Aerua sanguiolenta [Linn.] Blume
[=**A. scandens** Wall.]
Achyranthes aspera Linn.
Pupalia lappacea Juss.
Alternanthera sessilis R. Br.
***Alternanthera pungens** H.B.&K.
[=**A. repens** Link]
***Alternanthera paronychioides** St. Hill
[=**A. polygonoides** R.Br.]
***Gomphrena celosioides** Mart.

Chenopodiaceae

Chenopodium album Linn.

Chenopodium murale Linn.
***Chenopodium ambrosioides** Linn.
Kochia indica Wt.
Suaeda maritima [Linn.] Dumort.
Salsola baryosma [R. & S.] Dandy
[=**S. foetida** Del.]
Beta vulgaris Linn.
Spinacia oleracea. Linn.

Polygonaceae
Polvgonum plebejum R. Br.
Polygonum barbatum Linn. subsp. **gracile** Danser
(=**P. serrulatum** Hook. f.)
Polygonum glabrnm Willd.
Rumex dentatns Linn.
Antigonon leptopus Hook. & **Arn.**

Aristolochiaceae
Aristolochia bracteata Retz.

Proteaceae
Grevillea robusta A. Cunn.

Loranthaceae
Dendropthoe falcata (Linn. f.) Ettings
(=**Loranthus longiflrous** Desr.)

Euphorbiaceae
Euphorbia nerifolia Linn.
Euphorbia dracunculoides Lamk.
Enphorbia hypericifolia Linn.
Euphorbia hirta Linn.
Euphorbia prostrata Ait.
***Euphorbia geniculata** Orteg.
Euphorbia pulcherrima Willd. ex Klotz.
(**Poinsettia pnlcherrima** R. Grah.)
Securinega virosa (Roxb. ex Willd.) Pax & Hoffm.
(=**Fluggea microcarpa** Blume.)
Melanthesa rhamnoides (Retz.) Blume.
(=**Breynia rhamnoides** Muell.-Arg)
Phyllanthus madraspatensis Linn.
Phyllanthus fraternus Webster
(=**P. niruri** Hook. f.)
Emblica officinalis Gaertn.
(=**Phyllanthus emblica** Linn.
Croton bonplandianum Baill.
(=**C. sparsiflorum** Morong.)
Chrozophora rottleri A. Juss.
Chrozophora prostrata Dalz.
Ricinus communis Linn.

Urticaceae
Pouzolzia pentandra Benn.

Moraceae
Morus indica Linn.
Morus alba Linn.
Streblus asper Lour.
Artocarous heterophyllus Lamk.
(=**A. integrifolius** auct. non Linn. f.)
Ficus bengalensis Linn.
Ficus religiosa Linn.
F. lucescens Blume.
(=**F. infectoria** Roxb.)
Ficus glomerata Roxb.
Ficus palmata Forsk.
Ficus carica Linn.

Cannabinaceae
Cannabis sativa Linn.

Salicaceae
Salix tetrasperma Roxb.
Salix babylonica Linn.

Ceratophyllaceae
Ceratophyllum demersum Linn.

CLASS II MONOCOTYLEDONES

Hydroeharitaceae

Hydrilla verticillata (Linn.f.) Royle
Vallisneria spiralis Linn.

Orchidaceae

Zeuxine strateumatica (Linn.) Schltr
(=**Z. sulcata** Lindl).

Musaceae

Musa paradisiaca Linn.
(=**M. sapientum** Linn.)

Zingiberaceae

Curcuma longa Linn.
Zingiber officinale Rose.

Amaryllidaceae

Crinum difixum Ker-Gawl.
(=**C. asiaticum** Roxb.)

Agavaceae

Agave wightii Dr. & Prain

Dioscoreaceae

Dioscorea bulbifera Linn.

Liliaceae

Asparagus racemosa Willd.
Asphodelus tenuifolius Car.
Allium cepa Linn.
Allium sativum Linn.

Pontederiaceae

***Eichhornia crassipes** (Mart.) Solms
Monochoria hastaefolia Presl.
Monochoria vaginalis Presl.

Commelinaceae

Commelina nudiflora Linn.
Commelina benghalensis Linn.
Commelina attenuata Koen.
Murdania malabararica (Linn.) Brueckner
(=**Aneilema nudiflora** RBr.)
Cyanotis cristata Schult.f.
Cyanotis axillaris Schult. f.

Juncaeae

Juncus bufonius Linn.

Palmae

Phoenix sylvestris (Linn.) Roxb.
Livistonia chinensis R.Br.
Roystonea regia (H.B.&K.) O.F. Cook.
(=**Oreodoxa regia** H.B.&K.)

Typhaceae

Typha angustata Bory & Chaub.

Araceae

Colocasia esculenta (Linn.) Schott.
(=**C. antiquorum** Schott.)

Lemnaceae

Spirodela polyrhiza (Linn.) Schleid.
Lemna paucicostata Hegel.
Wolffia microscopica Kurz.

Alismaceae

Sagittaria guayanensis H.B.&K.

Aponogetonaceae

***Aponogeton natans** (Linn.) Engl. & Krause
(=**A. monostachyon** Linn. f.)

Potamogetonaceae

Potamogeton indicus Roxb.

Potamogeton crispus Linn.
Potamogeton pectinatus Linn.

Zannicheliaceae
Zannichelia palustris Linn.

Najadaceae
Najas graminea Del.

Eriocaulaceae
Eriocaulon siebol dianum Sieb.& Zucc.

Cyperaceae
Cyperus difformis Linn.
Cyperus niveus Retz.
Cyperus compressus Linn.
Cyperus cristatus Rottb.
Cyperus abulatus
(=**Cyperus iria** Linn.)
***Cyperus alulatus** Kern.
Cyperus eleusinoides Kunth
Cyperus rotundus Linn.
Cyperus corymbosus Rottb.
Cyperus triceps (Rottb.) Endl.
(=**Kyllinga triceps** Rottb.)
Cyperus kyllingia Endl.
(=**Kyllinga monocephala** Rottb.)
Cyperus globosus All.
(=**Pycerus globosus** Reich.)
Cyperus alopecuroides Rottb.
(=**Juncellus alopecuroides** Cl.)
Cyperus laevigatus Linn.
(=**Juncellus laevigatus** Cl.)
Cyperus pygmaeus Rottb.
(=**Juncellus pygmaeus** Cl.)
Mariscus dilutus Nees.
Mariscus paniceus Vahl var. **roxburghianus** Cl.
Eleocharis plantaginea R. Br.
Fimbristylis diphylla Vahl.
Fimbristylis diphylla Vahl Var. **annua** Cl.
Fimbristylis aestivalis Vahl.
Fimbristylis spathaceae Roth.
Fimbristylis monostachya Hassk.
Fimbristylis miliacea Vahl.
Bulbostylis barbata Kunth
Scirpus lacustris Linn.
Scripus affinis Roth
(=**S. maritimus** Linn. var. **affinis** Cl.)
Carex cernua Bott.

Gramineae
Apluda mutica Linn.
Dicanthium annulatum (Forssk.) Stapf
(=**Andropogon annulatum** (Forssk.)
Heteropogon contortus (Linn.) P. Beauv. ex Roem & Schult.
Imperata cylindrica Linn.
Mnesithea laevis (Retz.) Kunth
(=**Botboellia perforata** Roxb.)
Saccharum spontaneum Linn.
Saccharum bengalense Retz.
(=**S. munja** Roxb.)
Saccharum officinarum Linn.
Sorghum vulgare Pers.
Sorghum halepense (Linn.) Pers.
Vetiveria zizanoides (Linn.) Nash.
Coix lacryma-jobi Linn.
Zea mays Linn.
Brachiaria ramosa (Linn.) Stapf.
(=**Panicum ramosum** Linn.)
Brachiaria reptans (Linn.) Gard & C. E. Hubb.
(=**Panicum prostratum** Lamk.
Cenchus biflorus Roxb.
(=**C. catharticus** Delile)
Cenchrus cilaris Linn.
Cenchrus setigerus Vahl
(=**C. biflorus** Hook. f. non Roxb.)
Digitaria sanguinales (Linn.) Scop.
Digitaria setigara Roem & Schult.
Echinochloa colonum (Linn.) Link
Echinochloa crusgalli (Linn.) Beauv.
Eriochloa procera (Retz.) C.E. Hubb.
Oplismenus burmannii (Retz.) Beauv.

Oplismenus compositus Beauv.
Panicum trypheron Schult.
Paspalidium flavidum (Retz·) A. Camus
Paspalum commersonii Lamk.
(=**P. scrobiculatum** Linn.)
Pennisetum typhoides (Burm.) Stapf & C. E. Hubb.
(=**P. typhoideum** Rich.)
Setaria glauca (Linn.) P. Beauv.
(=**Panicum glacum** Linn.)
Setaria palmifolia (Koen.) Stapf.
(=**Panicum plicatum** Willd.)
Setaria tomentosa (Roab.) Kunth
(=**Panicum tomentosum** (Roxb.)
Polypogon monspeliensis (Linn.) Desf.
Aristida funiculata Vein.
Aristida mutabilis Trin. et Ruper.
Aristida setacea Retz.
Arundo donax Linn.
Phragmites karka (Retz.) Trin. ex Steud.
Avena sativa Linn.
Bambusa sp.
Chloris inflata Link.
(=**C. barbata** (Linn.) Sw.
Chloris dolichostachya Lagasc.
(=**C. incomoleta** Roth.)
Cynodon dactylon (Linn.)
Achrachne racemosa (Heyne.) Ohwi
(=**Eleusine verticellata** Roxb.)
Dactylectenium aegyptium (Linn.) P. Beauv.
(=**Eleusine aegyptia** (Linn.) Desf.)
Desmostachya bipinnata (Linn.) Stapf.
Eleusine indica (Linn.) Gaertn.
Eragrostis ciliaris (Linn.) R.Br.
Eragrostis japonica (Thumb.) Trin.
(=**E. interrupta** var. **tenuissima** Stapf ex Hook. f.)
Eragrostis poaeoides P. Beauv.
(=**E minor** Hochst.)
Eragrostis tenella (Linn.) Beauv. ex Roem. et. Schult.
(=**E. amabilis** (Linn.) Wt. et Arn, ex Hook et Arn)
Eragrostis tremula Hochst. ex Steud.
(=**E. multiflora** Trin.)
Eragrostis nuiloides (Retz.) Nees ex Steud.
Leptochloa panicea (Retz.) Ohwi
(=**L. filiformis** Hook. f. non P. Beauv.)
Hygrorhiza aristata (Retz.) Nees
Poa annua Linn.
Oryza sativa Linn.
Perotis indica (Linn.) O. Kuntze
(=**P. latifolia** Ait)
Sporobolus diander (Retz.) P. Beauv.
Tragus biflorus Schult.
Hordeum vulgare Linn.
Triticum aestivum Linn,
(=**T. vulgare** Vill.)

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Rabi Common Weeds Of Kanpur District

By
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[Communicated by Dr. S. S. Saxena Economic Botanist, Govt. of U. P. India]

The district of Kanpur is a part of the tra-ct known as the lower doab comprising the south-eastern extremity of the land lying beetween the river Ganga & Yamuna. The greatest breadh from east to west is about 64 miles. The district lies between tht parallels of 25°26, & 26°58, north latitude & 79°31, & 80°34, east longitude. The distr-ict constitutes an alluvial plane which slopes gently from north-west to south-east in which direction all the rivers flow. The fall of gradient is very gradual which drops from 451 feet in the extreme north to about 396 feet above sea level in the extreme south. The centre of the doab is somewhat lower than the Ganga's bank but the gradi-ent is similar. The high bank of Yamuna is somewhat less elevated than that of Ganga.

The average annual rainfall for the entire district is 32. 15" The varitions from tahsil to tahsil is slight but signficant. The tahsils in the west namely Derapur & Pukh-rayan receive on an average about 2 to 3 inches of less rainfull than the tahsils in the east. The average minimum temp is 66° F. The annual relative humidity is 66% The months of July, Aug & Sept. are the most humid followed by those of Dec. & Jan. The langs factors for the district is 31.8 mm. per degree centigrade & the Mayers quotient is 77. This shows that the climate of the district can be considered as semi-arid giving rise to soils characterised as grey-steppe of the international classifica-tion. The natural vegetation consists of grasses & shrubs with occasional jungle of Dhak (**Butea frondosa**)

SOIL TYPES & THEIR CHARACTERISTICS.

The soils found in the district according to the revenue authorites consist of the ordinary doab soils known by their usual names viz bhur or sand on the ridges, mat-iar or clay in depression & domat or loam on the levels. With regard to the soils of the district, Kanpur has been divided into six natural soil regions. The broad differen-tial characters of these soil types are given in table 1.

TABLE I. DIFFERENTIAL CHARACTERISTICS OF SOIL TYPES IN KANPUR DISTRICT

Particulars	Type I	Type II	Type III	Type IV	Type V	Type VI
Profila development.	Immature	Slightly mature	Mature	Mature	Mature	Mature
Colour	Grey	Dark grey	Reddish brown	Ash grey to dark grey	Dark grey to grey brown	Yellow grey to yellow brown
Concretions	Ill-defined	Prominent	Absent	Kankar Present	Small nodules present	Absent
Texture	Sandy	Loam or clay loam	Sandy loam	Clayey loam to clay	Sandy loam to loam	Loam to sandy loam.
pH	7-8	7-8 & above	6.2-7.4	7. 2.-8.8	6. 6-7. 8	Below 7
Lime	3%-4%	Less than 1 % more at bottom	Less than 1 %	Average to high	Average to high	Average
Clay	Poor	Average to high	High in sub-soil	Very High	Moderate	Average to High
Soluble Salts	Average	Average to High	Poor	Highest in Distrit	Average	Poor
Drainage	Imperfect	Fair	Good	Very poor	Fair	Good

A study of the weed flora of the rabi crops in the above soil tyepe was undertaken in the year 1960. The study continued for three years. During this period fields were visited every fortnight. A total number of thirty six weeds were collected from rabi crops. Of these, three belong to monocotyledons and thirty three to Dicotyledons. These are enumerated below and have been arranged according to Benth. & Hooker's system of classification. Brief descriptions of the weeds along with the frequency of their occurence in the differnt crops are given. Every effort has been made to bring the nomenclaluce uptodate.

Dicotyledons

Ranunculaceae

11. **Ranunculns scleratus** Linn.

Annual erect herb, leavss lobed, flowers yellow, arranged in cymes. Frequent in pea and mustard fields & along river bank.

Fumariaceae

2. **Fumaria indica** Pugsley
(= **Fumaria parviflora**, w. & A. non.) Lamk.)

Annual herb. leaves much divided. Flowers small, purplish, in racemes. Common in wheat fields.

Caryophyllaceae

3. **Vaccaria pyramidata** Medik.
(= **Saponaria vaccaria** Linn.)

Annual herb. Leaves both radical and cauline. Flowers in dichotomous cymes. Rare in wheat field.

4. **Spergula arvensis** Linn.

Annual herb, stem branched from the root, geniculate. Flowers white, in cymes Occasional in wheat, pea & mustard field.

Leguminosae
Sub- family-Papilioraceae.

5. **Melilotus Parviflora** Desf, DC.

Annual herb. Flowers pale yellow, in racemes. Common in wheat, pea & mustard field.

6. **Medicage sativa** Linn.

Annual herb, flowers in racemes. Pod forming a double spiral. Comman in wheat, pea and mustaed fields.

7. **Lathyrus sativus** Linn.

Annual climling herb with pinnate leaves. Flowers solitary, white. Occasional in wheat fields.

8. **Vicia hirstua** koch

Annual climbing herb with pinnate leaves ending in tendrrls. Flowers in peduncled racemes. Pods hairy 2-3 seeded. Freqent in wheat, pea & mustard fields.

9. **V. sativa** Linn.

Annual climbing herb with pinnate leaves. Flowers solitary, red-blue. Pods long 8 seeded. Frequent in wheat, pea & mustard fields.

Rosaceae

10. **Poteutilla snpina** Linn.

Annual herb, hairy, stems spreading, leaves pinnate. Flowers solitary, yellow. Frequent in fields along rivers bank.

Ficoideae

11. Mollugo hirta, Thumb.

Annual herb, stem prostrate, leaves usually obovate, opposite or whorled, flowers axillary sessile clustered. Rare, present mostly in soil type. VI.

Compositae

12. Eclipta prostrata (Linn.) Linn.
(=**Eclipta alba** Hassk.)

Annual herb. Leaves, sessile, oblong lanceolate. Flowers in small axillary heads. Occasional in mustard fields.

13. Gnaphalium indicum Linn.

Annual herb softly cottony, stems many from the root ascending leafy, leaves linear-obovate. Heads small.
Rare in pea fields.

14. Launea asplenifolia DC.

Glabrous herb, radical leaves sinuate lobed, cauline few, flowering stems from root, heads small 1/2″ terminal yellow.

Very rare inside the field but present in sufficient numbers along the margins.

15. Pluchea lanceolata oliv.

Shrubby, hoary-pubescent, leaves sessile very coriaceous oblanceolate, heads in compound corymbs.
Occasional in the margins of fields.

16. Sphaeranthus indicus Linn.

Low annual with spreading branches, leaves obovate-oblong toothed, heads small in terminal solitary globose clusters.

Present in sufficent numbers in the fields along river bank.

17. Vernonia cinerascens schultz-Bip.

Low shrubby, much branched, heads few small solitary of the divaricating branches of terminal cymes, pappus white. Rare, only in mustard fields.

18. Xanthuim strumarium Linn.

Annual, coarse rough herb., leaves petioled orbicular lobed, heads in terminal and axillary racemes. Occasional, in certain pea fields.

Primulaceae

19. Anagallis arvensis Linn.

Slender annual herb, erect or procumbent, leaves sessile ovate cordate, flowers axillary solitary peduncled, ebracteate blue. Common in wheat, pea and mustard fields.

Chenopodiaceae

20. Chenopodium album Linn.

Erect herb, leaves rhombic deltoid or lanceolate, flowers in axillary clusters.

Frequent in wheat & pea fields. Less frequent in mustard fields.

Polygonaceae

24 Polygonum plebejum Br.

Annual herb, diffusely branched, prostrate, internodes usually shorter than leaves, flowers minute clustered pink.

Rare, present mostly in fields along river bank.

Euphorbiaceae

22. Euphorbia thymifolia, Burm.

Small annual, branches prostrate, leaves opposite 1/6-1/3 in. Inflorescence cyathium axillary especially in crowded terminal branchlets.

Occasional rare.

23. Euphorbia dracanculoides, Lamk.

Annual glabrous herb, stems erect. branched dichotomously; leaves sissile linear lanceolate. Inflorescence cyathium solitary in leaf axil.

Very rare, found only in soil type VI

24. Euphorbia hirta, Linn.

Annual erect herb. Leaves shortly petioled. Inflorescence cyathuim.

Rare inside the crops. Common along the margins of crop fields.

Convolvulaceae

25. Convolvulus arvensis, Linn.

Annual twining herb, leaves hastate, corolla funnel shaped purplish.

Rare in rabi crops.

Solanaceae

26. Nicotiana plumbaginifolia, Viv.

Annual erect herb, leaves oblong, corymb branches elongated forming very lax racemes.

Occasional in the rabi crops.

Scrophulariaceae

27. Celsia coromandelina, Vahl symb

Annual tomentose herb, root leaves petioled lyrate-pinnatifid, cauline sessile oblong-ovate, racemes simple or panicled.

Present only in fields along Pandu river.

28. Veronica anagallis aquatica, Linn.

Annual herb erect, leaves sessile or lowest petioled oblong oblong-lanceolate or linear oblong base usually cordate, racemes long axillary.

Common in fields along river bank.

Verbenaceae.

29. Lippia nodiflora, Rich.

Annual, creeping, minutely strigose leaves cuneate spathulate serrate, heads 1/2 by 1/4 in, ovoid or cylindric.

Present in sufficent numbers in the fields along river bank.

Labiatae

30. Leucas aspera, Spreng.

Annual erect herb, whole plant fragrant, whorls. large terminal axillary.

Rare inside the crops.

Amarantaceae

31. Aerua javanica, Juss.

Hoary-tomentose herb, leaves linear to oblanceolate, spikes elongate.

Rare in wheat, pea & Mustard fields.

32. Alternanthera sessilis, R. Br.

Prostrate herb, leaves opposite, heads axillary often clustered, flowers small white.

Occasional in wheat, pea & musterd field.

33. Gomphrena globosa, Linn.

Herb erect branched hairy, leaves short petioled, heads large globose with two leafy bracts. Very rare inside the crop fields.

Monocotyledons.

Liliaceae.

34. Asphodelus tenuifolius, cavan in Anual cienc Nat.

Annual herb with radical leaves and white flowers arranged in raceme. Frequent in wheat, mustard and pea fields.

Cyperaceae

35. Cyperus rotundus, Linn.

A pestiferous weed. Stolons slender, hardenig into wiry roots, thickened into black woody ovoid tubers. Inflorescence umbellate.

Common in wheat pea, and mustard fields.

Gramineae.

36., Cynodon dactylon, Pers.

Perennial creeping grass. Stem prostrate, spikes radiating, green.

Common in wheat, pea and mustard fields.

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Some Important Fungi of Meerut* Part I

G. P. Bhatt. (**)

INTRODUCTION

The fungus diseases of plants are noticeable causing enormous losses each year in every country of the world. Thus it is beneficial to the people of that country to know about the causal organisms of disease and abopt effective methods for their eradication.

Butler and Bisby [1931] were the first to compile the "Fungi of India." Further supplements to this work were published by Mundkur [1938]; Ramakrishnan and Subramanian [1956]. Regional fungal floras of different states have been published as: "Fungi of Bengal" by T. C. Roy [1948]; "Fungi of Bombay" by Uppal etal [1935] and supplements by Thirumalachar [1956] and R. Krishanan [1952] from Madras; Syed Vaheeduddin [1955] from Hyderabad; Chona and Munjal [1959-1963] from New Delhi; Arya [1964] from Rajasthan have also recorded many fungi. Although Chowdhury [1932] from Lucknow; Mitter and Tandon [1930-37] from Allahabad have describe the fungi of different localities but no systematic collections have so far been made from western U.P. [Meerut].

In the present investigation a limited study of fungus diseases of cereals, millets and pulses of Meerut have been taken in to consideration since no work has appeared on these aspects.

TOPOGRAPHY

Meerut is situated at 29°01 N latitude and 77°43 E longitude and is about 730 feet above the mean sea level. The average rainfall is about 30" in normal years. The soil is very much fertile and of sandy loam in quality.

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MATERIAL AND METHODS

The agricultural or crop growing area have been divided into four zones to simplify the job, for fungi collections. The infected parts of plants only were collected in a vasculum. Besides this some material was fixed in F. A. A. and some infected specimens at the very spot were presred to obtain good herbarium. I took special care in drying to avoid spoilage of herbaria because of growth of some saprophytic fungi.

OBSERVATIONS

The necessary field data and symptoms of the diseases have been listed in the following manner:—

1. No. of collection.
2. Name of the host infected.
3. Part or parts of the host infected.
4. Symptoms of the disease.
5. Name of the disease.
6. Causal organism.

LIST OF THE GENERA

No. of Collections.	Name of the host infected.	Part (s) of the host infected.	Symptoms of the disease.	Name of the Disease.	Causal organism.
1.	Wheat	Inflorescence	Black to Brown	Loose sumt	**Ustilago tritici**
2.	,,	Leaves	Orange pustules	Orange rust	**Puccinia recondita**
3.	,,	,,	Yellow spots, Black pustules	Yellow rust	**P. steriiformis**
4.	,,	,,	Brown (concentric) spots.	Alternaria Blight	**Alternaria** sp.
5.	,,	,,	Small brown spots,	Leaf spot	**Helminthosporium-tritci-repentis.**
6.	Barley	Ears	Black	Covered smut.	**Ustilago hordei.**
7.	,,	Leaves & leaf sheaths	Yellow elliptical stripes.	Stripe disease	**H. gramineum.**

No. of Collections.	Name of the host infected.	Part (s) of the host infected.	Symptoms of the disease.	Name of the Disease.	Causal organism.
8.	Oat	Inflr. (Panicle)	Black flrs.	Covered smut	**Ustilago kolleri**
9.	,,	Leaves	Light reddish brownish patches.	Leaf spot	**H. avenae.**
10.	Rice	Leaves	Black spots.	Leaf smut	**Entyloma oryzae.**
11.	,,	Leaves and glumes	Black dots.	Black leaf spot.	**Chaetomella** sp.
12.	,,	Leaves & inflr.	Brownish black dots	Curvularia blight.	**Curvularia lunata**
13.	,,	,,	Dark brown black spots.	Sesame leaf spot.	**H. oryzae.**
14.	,,	Entire plant	Brown spot	Black leg	**Phoma oryzae.**
15.	,,	Leaves and culms	Dark Brownish black spot	Phyllosticta blight	**Phyllosticta glumarum**
16.	,,	Spike-let	Brown spindle shaped lesion	Blast or rotten neck	**Piricularia oryzae.**
17.	Maize	Inflr.	Small black spots.	Alternaria blight.	**Alternaria** sp.
18.	,,	Leaves	Scattered black spots	Anthracnose	**Colletotrichum graminicolum.**
19.	,,	,,	Brown spots	Leaf spot	**Curvularia lunata.**
20.	,,	Male inflr.	Brown to black lesions	Fusarial blight	**Fusarium** sp.
21.	,,	Leaves	Yellow spots	Leaf blight	**H.turcicum**
22.	Bajra	Ears	Inflr. turns into scattered leafy structure	Downy mildew Or Green ear	**Sclerospora graminicola**
23.	,,	,,	Wooly inflr.	Wet-rot	**Choanephora** sp.
24.	,,	Leaves	Black sooty mass	Sooty mold	**Capnodium** sp.
25.	,,	Ears (Grains)	Green to black enlarged grains	Smut of Bajra	**Tolyposporium penicillariae**
26.	,,	Leaves	Reddish brown pustules	Rust of Bajra	**Puccinia penniseti**

No. of Collections.	Name of the host infected.	Part (s) of the host infected.	Symptoms of the disease.	Name of the Disease.	Causal organism.
27.	Bajra	Ears (grains)	Blackish	Alternaria blight	**Alternaria** sp.
28.	,,	Leaves & ears	Small black spots.	Leaf spot	**Curvularia penni--seti**
29.	,,	Ears	Fur like covering	Top rot	**(i)Fusarium poae. (ii)F.camptoceras.**
30.	,,	Ears (grains)	Brownish black	Black grain	**Helminthosporium** sp.
31.	,,	Leaf, leafsheaths & ears	Pallid areas on the leaves	Black leg	**Macrophomina phaseoli.**
32.	,,	Ears	White fine threads	Soft rot	**Penicillium** sp.
33.	,,	Leaves	Light to dark brown spots	Leaf spot	**Piricularia** sp.
34.	,,	,,	Black irregular dots	Anthracnose	**Vermicularia** sp.
35.	Jowar	Cobs	Blackish felt	Wet rot	**Choanephora** sp.
36.	,,	Leaves	Large spots with irregular brown margins	Red leaf spot	**Colletotrichum graminicolum.**
37.	,,	Cobs	Grains converted into a sporesac.	Grain smut	**Sphacelotheca-sorghi.**
38.	,,	,,	Brown to black colour	Discolouring of grains	**(i)Curvularia falcata. (ii) C. lunata.**
39.	Jowar	Leaves	Scattered brown aeras.	Leaf blotch	**Macrophomina phaseoli.**
40.	,,	,,	Black dots	Black leaf spot	**Phyllosticta sorghina**
41.	Lobia	Seedlings	Wilting of the seedlings	Damping off	**Pythium debaryanum.**
42.	,,	Pods and leaves	Sooty coloured spots	Alternaria blight	**Alternaria vignae**
43.	,,	Leaves	Reddish brown pustules	Leaf spot	**Cercospora canascens.**

No. of Collections.	Name of the host infected.	Part (s) of the host infected.	Symptoms of the disease.	Name of the Disease.	Causal organism.
44.	Lobia	Leaves and pods	Black spots lesions	Bean Anthracnose	**Colletotrichum-capsci.**
45.	,,	Leaves	Brownish spots on the upper surface.	Blight disease	**Macrophomina-phaseoli.**
46.	,,	,,	Tan coloured spots	Leaf spot	**Myrothecinm roridum.**
47.	,,	,,	Blackish lesions.	Sclerotial rot	**Sclerotium rolfsii**
48.	Gram	Entire Plant.	Wilting of the plant	Wilt of gram	**Fusarium orthoceras** var. **ciceri.**
49.	Urid	Leaves, petiole and stems	Brown to Black galls	Gall formation.	**Synchytrium phaseol iradiati**
50.	,,	,,	Dark black spot	Leaf spot or Anthracnose	**Colletotrichum** sp
51.	,,	Levaes	Dark Brown spot	Blight	**Macrophomina-phaseoli.**
52.	,,	,,	Brownish small spots	Leaf spot	**Myrothecium rorid**
53.	,,	,,	Blackish dots	Leaf blotch	**Phyllosticta** sp.
54.	Bakla	Seedlings	Black patches at the soil level	Rot disease	**Urophlyctis** sp.
55.	Bakla	Seedlings	Wilting	Damping off	**Pythium paroecandrum**
56.	Arhar	Stems	Dark black spots	Anthracnose	**Colletotrichum cajani.**
57.	,,	Roots and stems	Wilting	Wilting	**Fusarium udum.**
58.	Gawar	Leaves	Black spots with concentric rings	Leaf spot	**Alternaria brassicae.**
59.	,,	Seedlings (leaves and stem)	Black streaks near the base of the leaf and axils of the leaves	Fusarium blight	**Fusarium moniliforme.**

No. of Collections.	Name of the host infected.	Part (s) of the host infected.	Symptoms of the disease.	Name of the Disease.	Causal organism.
60.	Gawar	Leaves	Oily spots with circular zonation.	Leaf spot	**Myrothecium roridum**
61.	Pea	,,	Pale green yellow spots on the lower side	Downy mildew	**Peronospora pisi.**
62.	,,	,,	Brown to black irregular spots	Blight	**Alternaria brassicae** var **phaseoli.**

SUMMARY

62 collections of fungi have been made from the fields of respective crops in the vicinity of Meerut district. Most of the fungi infecting the said crops were found to belong to class Deuteromycetes. Basidiomycetes, Phycomycetes and Ascomycetes were found in diminishing order. The members of Myxomycetes could not be collected (TableNo.1).

TABLE No. 1

Class of Fungi	No. of Fungi collected
1, Myxomycetes	Nil
2. Phycomycetes	8.
3. Ascomycetes	1.
4. Basidiomycetes	9.
5. Deuteromycetes	44.

TABLE No. 2.

Range of Temperature	No. of Fungi collected.
15°C — 20°C	Nil
20°C — 25°C	11.
25°C — 30°C	27.
30°C — 35°C	24.

TABLE No. 3

Relative Humdity	No. of Fungi collected,
80 °/° — 100 °/°	31.
60 °/° — 80 °/°	12.
40 °/° — 60 °/°	19.
Below — 40 °/°	Nil.

Some of the fungi were found to be more destructive to these crops, others, however, caused minor incidence during normal weather conditions.

The following conclusions have been made on the study of atmospheric conditions, particularly humidity and temperature that influence the development of diseases in the field.

(a) Fungi grow luxuriently in rainy season on millets and some pulses.

(b) Fungi are more prevalent between 25°C — 35°C (Table No. 2).

(c) Fungi have been found better developed in high relative humidity i. e. in between 80-100% (Table No. 3).

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Chromogenic Reactions of Zirconium With Solochrome Black T.

O. P. Sinha and T. C. Sharma.

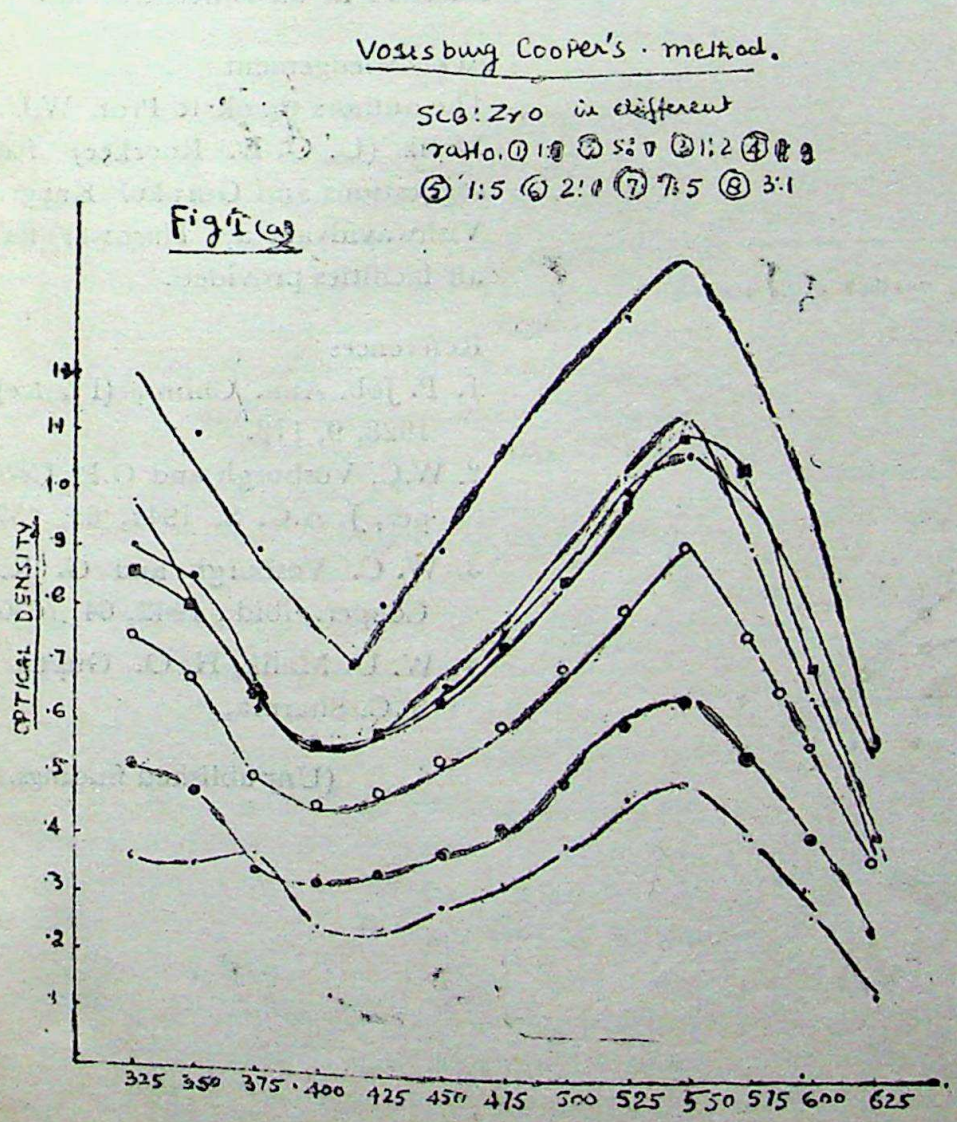
(Chemistry Department, Gurukul Kangri Vishwavidyalaya, Hardwar.)

Sodium 1-(1-hydroxy-2-naphthylazo) 6-nitro-2 naphthol-4sulphonate, commonly known as solochrom black T (SCBT colour-index 203.) has been extensively studied in this laboratory as a chelating reagent.

In the present communication, the formation of coloured chelates of zirconium (IV) with SCBT is reported and suggestions made for the use of SCBT as a chromogenic reagent.

Experimental :

Spectrophotometery absorbance were measured with a Spectrophotometer-colorimeter, Bausch and Lomb spectronic-20. pH measurement were made with a Multaoskop V(No. 525) pH meter operated on 220V a.c. mains.



Reagents :

Solutions of zirconium oxy chloride (B.D.H., A.R. Grade) was prepared and standarised by the usual methods. It was in 0.2 M HCl and used fresh to avoid ageing effects.

Solochrom blach T:

Aq.—alcoholic solution of SCBT (B. D. H. quality) was prepared.

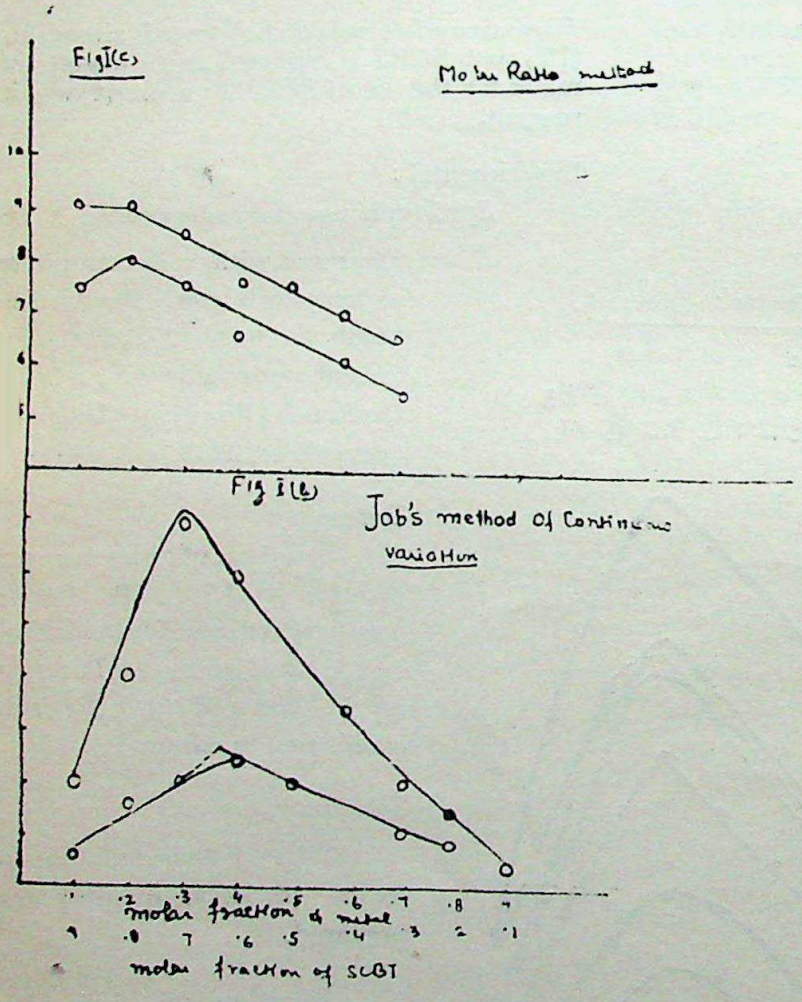
Solutions of diverse ions were prepared from reagent grade chemicals.

Results :

The nature of the complex was determined by Vosburgh and Cooper 1, 2, 3. method. Suitable mixtures of salts and

SCBT of varing M:SCBT ratio were prepared while the pH was kept constant. The absorbance of each mixture was found suitable over 450-625mu range. The slope and molar ratio mothods were also employed to confirm the chelates. Fig. I It shows some typical results with SCBT-ZrO system, and their stoichmeteric ratio 2:1 was further confirmed our earlier results by polarographic methods.

The effect of the pH on the complex was studied and the pH range (8-11) where λ max. remained constant.



Effect of Diverse Ions :

The effect of various ions on the colour reactions was studied. Cd(II), Pb(II), Cu(II), Co(II), Zn(II) Ni(II), must not exceed 100ppm.

Sc(III), Y(III), V(V), U(VI) flouride, Citrate and oxalate interfere at all concentrations.

Acknowledgement

The authors thank to Prof. W.U. Malik (U. O. R. Roorkee) for suggestions and Gurukul Kangri Vishwavidyalaya, Hardwar for all facilities provided.

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4. W. U. Malik, H. O. Gupta, T.C. Sharma,

(Unpublished findings.)

Some Findings About Pholidota Articulata Lindl

Part I Chromatographic separation and charactarization of carbohydrates in **Pholidota articulata** Lindl.

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(Survey unit of medicinal plants, Gurukul Kangri Vishwavidyalaya.)

Introduction-Pholidota articulata Lindl (Orchidaceae) known locally as Jiwanti and is used by most of the local pharmacies of Hardwar and Dehradun as a substitute for the official drug **Dermotrichum Fimbriatum** Bl. (Orchidaceae) Each part of the plant is said to have been used in defferent diseases. It is considered tonic, stimulant and is supposed to be remover of old-age effect. In our investigations we have concentrated on the stem of the plant, which is epiphytic jointed and yellowish brown in colour. No. systematic work seems to have been done on the chemical composition and its uses in the treatments. In the present paper attempts have been made to analyse the plant material chromatographically and some interesting finding are given below:

Experimental

In a search for systems suitable for determination of the various reducing compounds, attention was drawn to ammoniacal silver nitrate, 2, 3, 4, 5, 6, 7. the so called Tollens reagent. This reagent commonly used in qualitative analysis, is characterised by a high sensitivity and the ability to react with a wide variety of icompounds. As a result of such reactions elementary silver is deposited on the paper.

Reagents

Glucose, fructose, xylose. rhamnose, manitol, rfinose, inositole, silver nitrate commercial A. R. grade, were used in all experiments. It was found that ammonical silvernitrate of low concentration is insufficient for the compelete oxidation of more stable substances. Therfore solutions containing 15-20 per-cent of silver nitrate in concentrated ammonia were used in these experiments. Sodium hydroxide, which accelarates (0.01 MM) the reaction was found to be an indispensable component of these solutions.

Paper Chromatography

Chromatographic separations were made on Whatmann filter paper No. 1 at room temperature (25') using the following solvent system :

n—butanol : acetic acid : water : : 6 : 1: 2.

Before further operations, the Chromatograms were air dried for 24hrs. Chrom-

atogrms were placed horizontally on specially designed racks and sprayed. Wet chromatograms were transfered to 105'c. The optimum heating time is 15-20 minutes. These reaction conditions cause the formation of dark brown-black spots on a dark yellow background. Excess of the tellen's reagent was removed using 0.02percent aqueous ammonia.

Extraction of the plant materials :

500 gms. of fresh and dry pieces of stem were crushed and treated with petrolium other (40-60) for about 8hrs. to remove the fatty matter. defatted material was then extracted with 80 percent v/v ethanol, filtered and conncentrated. The extract thus obtained was used in chromatographic separation of fror sugars.

Results

The extract of the plant material so obtained, was allowed to flow simultaneously with authentic sample of sugars on the same paper. Since the sugars present in the stem could not be separated by a single flow of the solvent, multiple development technique applied for clear and distinct separation. Tee best results were obtained on 4th development of the chromatograme. The following sugars with Rf. values were detected in the stem of pholideta:

Name of the sugar	Rf observed	Name of the sugar	Rf observed
l—glucose	0.20	fructose	0.25
rhmnose	0 37	l—arabinose	0.24
d—xylose	0.31	raffiinose	0.10

Work is in progress.

Summary :

Phdiola articulata lind (orchidaceae) known as Jiwanti in the local area, has been analysed for sugars Chromatographically and some important sugars are reported.

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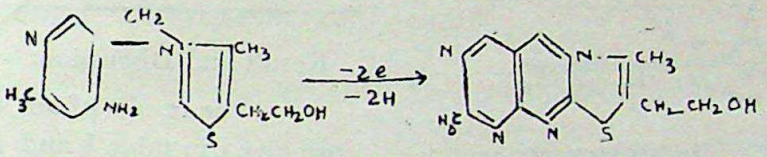
Amperometric Titrations of Thiamine [Vitamin B_1] With Hexacyanoferrate [iii]

Hari Om Gupta and T. C. Sharma.

Thiamine is readily oxidised (1) under controlled conditions by alkaline hexacyanoferrate (III). Thiochrome is formed according to the equation :



$$2Fe(CN)_6^{\cdots\cdots} + 2e = 2Fe(CN)_6^{\cdots\cdots}$$

Horwith (2) used polarographic, chromatographic and colorimetric methods for its estimation while Mickelson and Yamamoto (3) reviewed analytical methods including physico-chemical, enzymatic and micro biological techniques developed by many workers over the years.

Pletch (4) estimated thiamine polarographically in pharmaceutical products. Red precipitate of thiamine with complex anion $B.I_4^-$ was dissolved in 10.0% rochelle salt solution to analyse at d.m.e. Tachi (5-13) investigated its polarographic behaviour and a number of workers (14-17) reported the application of catalytic waves for its estimation. But no direct polarographic methods for its estimation are available in literature. In this note amperometric titrations of thiamine with hexa cyanoferrate (III) are reported.

Apparatus :

A Heyrovsky Lp-55A manully operated polarograph was used with a Pye Scalamp galvanometer. The capillary characteristics in closed ciruit at O.OV vs. S. C. E. were m=O. *0035*gm,/sec. t=4. *30*/sec./drop.

Reagents :

Solutions of thiamine, hexacyanoferrate (III), lithium Chloride and sodiumhydroxide were prepared in doubled distilled water Their strength was determined by usual methods.

Procedure :

Direct amperometric titrations (thiamine in cell) and reverse (hexacyanoferrate III in cell) were carried out in 0.166M

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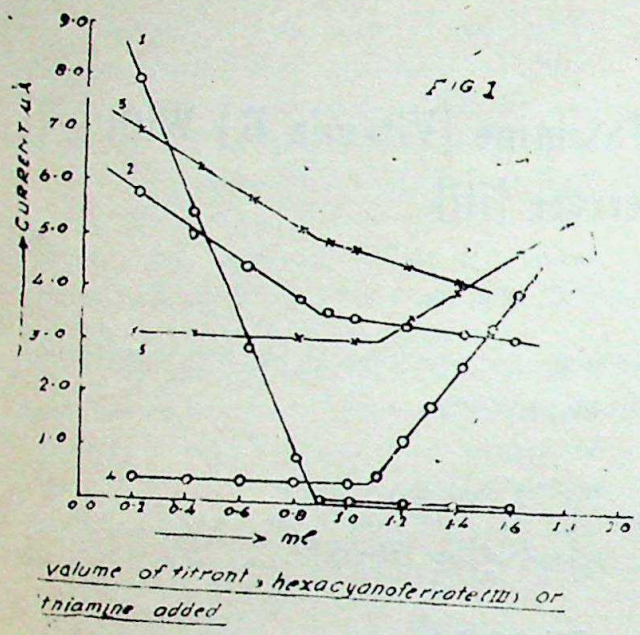

sodium hydroxide and 0.133M lithium Chloride at-0.35V vs. S.C.E. (Lying on the Plateau of the polarograms of 1.0x 10^{-3} M hexacyanoferrate III in 0.166M sodium hydroxide and 0.133M lithium chloride) Titrants were added from micro burette. Nitrogen was passed to stirr the solutions and current was recorded after a lapse of about four minutes.

TABLE I

Results of Estimation of Thiamine.

Amount present per 100 ml.	Amount found per 100 ml.
Reverse titrations:—	
1. 300 mgs.	301.00mgs.
2. 30.0mgs	29.95 mgs.
3. 3.00mgs.	2.99mgs.
Direct titrations:—	
4. 300.00mgs.	299.45mgs.
5. 30.00mgs.	29.78mgs.
6. 3.00mgs.	2.98mgs.

Result and Discussion:—

The results of amperometric titrations are given in table I and typical curves are shown in fig. I. From table—I it is evident that titrations may be carried out successfully with fairly dilute sulutions of thiamine. Errors of 0 3-0.6/were observed when 10^{-4} M Solutions were titrated. In direct titrations (thiamine in cell) quite sharp inflexion points were obtained even with very dilute solutions. However, in reverse titrations (Hexacyanoferrate III in cell) when reactants concentration was too low the curves deviated slightly from L-shape, but the point of interaction two branches of curves did not effect the accuracy.

Summary

Amperometric titrations of thiamine with hexacyanoferrate (III) in 0.166M sodium hydroxide and 0.133 M lithium Chloride at -0.35 U.US, S.C.E. are reported. Thiamine concentration upto 3 mgs/ 100ml was determined successfully with a error of 0.3-0.6%.

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Physico—Chemical studies on Chelation of p—Chloro Phenacylidene Aniline Oxime with Cu (II)

D R. Gupta, C. L. Taploo and Y. Singh

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p-Chloro phenacylidene aniline oxime has been employed as a chelating agent for Cu (II). Absorption spectral, chemical analysis and magnetic suceptibility data have been recorded for the complex.

Unlike other Schiff's bases, (1-4) those obtained from condensation of p-chlorophenylglyoxal and aromatic amines do not give colour reactions with metal ions. But when they are converted into their corresponding eximes, sensitive colour reactions are observed. The present communication concerns with the composition, isolation and magnetic susceptibility data of the Cu (II) complex.

Preparation of the Reagents :

p-Chlorophenylglyoxal hydrate was prepared by the oxidation of p-chloroacetophenone with SeO_2. Alcholic equimolar solutions of p-chlorophenylglyoxal hydrate and aniline were refluxed over a water bath for about an hour. The resulting soultion which solidified on cooling was separated and crystallized from hot ethanol. p-chlorophenacylidene aniline thus obtained was converted into its oxime by the usual method. A stock solution of Cu (II) was prepared by dissolving copper nitrate in absolute alcohol and its metal content estimated iodometrically.

Nature of the Complex :

Vosburg and Cooper's method (5) was employed in order to choose a proper wave lenght for studying various characteristics of the complex. All measurements were carried out at 450 mu. The mixtures were allowed to stand overnight for equilibration before carrying out absorbance measurements.

Stoichiometry of the Components :

Job's method of continuous variations, (7) slope ratio method(8) and molar ratio method(9) were used to determine the composition of the complex. A ratio 1 : 2, (M:L) was established for the complex which was further confirmed by the chemical analysis of the solid complex.

Isolation and Chemical Analysis of the complex :

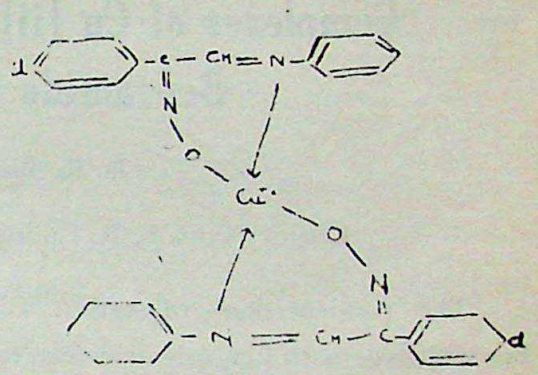
The Complex was isolated by adding

the metal ion to the ligand in the ratio of 1 : 2 and dried in vacuum. The solid mass thus obtained was repeatedly crystallized from ethanol.

A weighed quantity of the isolated complex was fused with the fusion mixture and copper oxide thus obtained was converted into copper sulphate, from which Cu was estimated iodometrically. Nitrogen was estimated by kjeldahl's method. (Found; Cu, 11.47°/₀, N, 5.09°/₀; Calculated Cu, 11.35°/₀; N, 4.87°/₀).

Structure of the Chelate :

The stucture of the chelate was confirmed by I. R. spectral studies of both the ligand the complex using Perkin-Elmer Infra cord spectrophotometer. The spectrum of the complex did not show the presence of the stretching frequency of the - OH group which was present in the ligand, showing thereby the binding of the metal with the ligand through the oxygen atom of the oxime by a covalent link. Further, there is a shift in the stretching frequency of azomethine group from 1600 cm^{-1} to 1540 $cm,^{-1}$ indicating the binding through nitrogen of azomethine group. The following structure may, therefore, be assigned to the comdlex :



Magnetic Measurements :

Magnetic susceptibility of the complex was determined at room temperature using Gouy's balance (I8.5 x 10^3 Gauss/Cm^2).The complex was found to be paramagnetic with an effective magnetic moment of 1.93 B.M. which is within the range, 1.70 to 2.20, expected for copper complex.

Summary :

p-Chloro phenacylidene aniline oxime has been employed as a chelating agent for Cu(II). Absorption spectral, chemical analysis and magnetic suceptibility data have been reported for the complex.

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Complexes of Cu [ii] and Fe [iii] with Ammonium ∝-Benzamido o-Chloro Cinnamate.

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The condensation of ortho Chloro Benzaldehyde with hippuric acid was reported by Singh.[1] It was found that its ammonium salt reacted with most salts except those which hydrolysed in water favourably giving a large sized molecule precipitate and some were distinguishable from others by their characteristics colours. This encouraged to study the complexes of ammonium salt of ∝-Benzamido O-Chloro Cinnamic acid with Cu (II) and Fe (III).

Experimrntal :

Copper sulphate and ferric ammonium sulphate used were of B.D.H. pure quality and ether was distilled over sodium. The solutions of the reagent and metall (ions) were prepared in conductivity water.

Preparation of the Complexes :

Bis (Ammonium ∝-benzamido O-Chloro Cinnamate) Cu(II).-About 35 ml. of reagent solution of (O.IM) strength were added to about 15 ml(0.1M) of copper sulphate. The whitish blue product which settled down was filterad throught a sintered funnel. The whole precipitate was transferred to a flask and about 100 ml. of ether was added to it. The mixture was refluxed and distilled for ether over a water bath for about 10 minutes. The hot reaction mixture was passed through filter paper and the green coloured filtrate was kept for crystallisation a vacum, when the crystals of the product appeared after a few hours.

Green crystals. m. p. 187°; Anal. Calc. for Cu $(C_{16}H_{11}O_3NCl)_2$ 1.5 H_2O C-55.53; H-3.61; N-4.05; Cl-10.26; Cu-9.18 Found C-55.00; H-3.40; N-4.32 Cl-10.10; Cu-8.98. Tris (ammonium ∝-benzamido O-Chloro Cinnamate)-Fe (III). It was carried out more or less by the same procedure, as described above.

Reddish yellow ppt m. p. 175°. Anal. Calc. for Fe $(C_{16}H_{11}O_2NCl)_3$ C-60.17; H-3.44; N-4.38; Cl-11.12; Fe-5.83 Found C-61.20; H-3.30; N-4.00; Cl-11.50; Fe-6.10.

The authors to express their thanks to Prof. R. N. Singh and Mr. G.C. Saxena, Chemistry Department, B. R. College, Agra for their keen interest and helpful suggestions.

Summary

Complexes of cu(II) and Fe(III) with ammonium α-Benzamido o—chloro cinnamate and their analysis was reported.

Reference :

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Gravimetric Determination of Cadmium with 6-Chloro-4-Nitro-1-Hydroxy-1,2, 3—Benzotriazole.

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Deptt. of Chemistry M.M. College Modinagar.

The use of 6-chloro-4-nitro-1-hydroxy-1, 2, 3-benzotriazole as the gravimetric reagent for the determination of silver has been reported earlier[1]. In the present communication we report the analytical application of this compound for cadmium. This ligand reacts quantitatively with Cd^{++}ions in solution forming a crystalline yellowish insoluble 2:1 (Ligand: Cadmium) complex. This forms the basis of the gravimetric determination of cadmium.

Preparation of reagent :—

The reagent R, viz. 6-chloro-4-nitro-1-hydroxy-1, 2, 3-benzotriazole was prepared by the method reported[2]. An alcoholic solution (1:1) of the reagent was used for all estimations. Stock solution of cadmium acetate (BDH) was prepared in water-alcohol containing few ml of acetic acid.

Procedure :

A known volume (1-20ml) of cadmium acetate was taken and diluted to about 50ml and warmed to nearly boiling. Now ligand was added slowly with constant stirring, a voluminous yellowish precipitate of cadmium complex immediately started accumulating down. After allowing to stand for 20-30 mts, the precipitate was filtered through a porous sintered glass crucible, washed first with water and finally with alcohol. The precipitate was dried in vacuum desiccator and weighed as $Cd(C_2H_2O_3N_4Cl)_2$. The gravimetric factor for the cadmium: Triazole complex is 0.2084. The results are summarised in table 1.

Table 1.

S. N.	Cd taken in soln. mg.	Wt. of Cd-complex mg.	Cd found mg.	Error %
1.	2.0	9.596	2.0	—
2.	4.0	19.097	3.98	0.5
3.	8.0	38.48	8.02	0.5
4,	10.0	48.17	10.04	0.4
5.	15.0	72·55	15.12	0.8
6.	20.0	96.209	20.05	0.5
7.	25.0	120.58	25.13	0.5
8.	35.0	168.95	35.21	0.6
9.	50.0	241.16	50.35	0.7

From the data in table 1, shows that Triazole can be effecetively employed as a gravimetric reagent for the rapid determination of Cd in solution containing 2:50 mg of the metal ions. solution containing 7·50 mg. cd^{++}ions are difficutly determined, since the voluminous precipitate then requires a longer period of time to filter. The precipitate is insoluble in water, acetone, ether, benzene, carbon tetra chloride, nitrobenzene and alcohol. Foreign cations such as Cu, Zn; Ag; Co; Ni, interfere.

Summary :

The use of 6-chloro-4-nitro-1-hydroxy-1, 2, 3-benzotriazole as the gravimetric reagent for the determination of cadmium has been reported.

References :

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Mechanism of Bromine Oxidations

Kinetics of Oxidation of Propionaldehyde by bromine in Aqueous Solution. Part III

V. P. Kudesia

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The kinetics of oxidation of propionaldehyde by bromine was studied. The reaction was found to be of the first order with respect to initial bromine concentration. The values of activation energy, $\triangle E$ KCals; frequency factor, $A Sec^{-1}$ heat of activation, $\triangle H$ KCals; and entropy of activation, $-\triangle S$ e.u., were found to be 16.1, 2.3×10^6 16.2 and 18.1 respectively. Reaction in acetate buffer provided an evidence that aldehyde hydrate is the reactive entity.

In the present communication the results of studies on the kinetics of oxidation of propionaldehyde by bromine water are reported.

All the chemicals were of AR (BDH) quality and their solutions were prepared in conductivity water. The reactions were carried out in a controlled thermostat varying within $\pm$ .05°C. Bromine solutions were standerdised immediately before use as it has been observed that if they were allowed to stand for a period of more than 50 minutes the kinetic results became irreproducible probably due to loss of bromine. Experiments were performed in black coloured bottles to avoid photo-chemical complications as the presence of light inhanced the reaction rate. As bromine water contains the species Br_2, Br^- and HOBr, hence low bromine concentretions were taken to avoid the effect of the equilibrium $Br_2 + Br^- \rightleftarrows Br_3^-$ since the equilibrium constant (1) for this is 0.17 at 25°C. The initial bromine concentrations were calculated by the method of Bartlett and Tarbell (2). The ionic strength was maintained at 0.2 by the addition of the required amount of sodium perchlorate. In all the experiments performed, rates Ko were determined (3) by plotting x/t against x and to extrapolate to x=o in which the value of x was calculated by the formula

$$X = \frac{(C_1 - C)N}{2\ V}$$

Where X is the number of moles of total oxident per litre consumed in time t, N is the normality of the thiosulphate, v is the Volume of aliquot (V=20 C.C) and C_1 and C are the number of ml of thiosulphate required after respectively zero time and time t.

At aldehyde concentration 0.1223M, the values of $k_0 \times 10^5$ in moles per litre per second were found to be 3.70, 3.58, 3.51, 3.45, 3.42, 3.2, 3.02, 2.83. for 7.0×10^{-3} M, 6.5×10^{-3} M, 6.2×10^{-3} M, 5.7×10^{-3}M, 5.5×10^{-3}M, 5.3×10^{-3} M, 4.7×10^{-3} M $(Br_2)_o$ respectively.

Variation of reaction rate with sodium acetate and acetic acid buffer concentration has also been investigated and it was observed that for 7.0×10^{-3} M $(Br_2)_o$, 0.1200 M aldehyde and at acetate concentrations between 0.01 to 0.15M, the value of $K_oAC \times 10^5$ in moles (per litre per second was found to be 5.56.)

The reaction was studied at 15°, 25°, 35°C and energy of activatin, $\triangle$EKcals, frequency factor, A Sec.$^{-1}$, heat of activatin, $\triangle$H Kcals and $-\triangle$Sc.u. were found to be 16.1, 2.3×10^6, 16.2 and 18.1 respectively at isobutyraldehyde (0.1078M), $(Br_2)_o = 7.0 \times 10^{-3}$M.

With the help of the results obtained above indicating that bromine molecule is the principal effective oxidant and with evidences provided by MC Tigue and Sime (4) that aldehyde hydrate was reactive entity, the following mechanism can be suggested.

$$RCHO + H_2O \rightarrow RCH(OH)_2 \quad [\text{Where } R = C_2H_5]$$

$$RCH(OH)_2 + Br_2 + B = RCOOH + HBr_2^- + BH^+$$

$$HBr_2^- \rightarrow H^+ + 2Br^-$$

Where RCHO represents isobutyraldehyde and B represents base.

The chemical analysis of the products of the oxidation of isobutyraldehyde has also shown that two moles of bromine ion and three moles of acid are produced for every mole of bromine used up, in agreement with the stoichiometry above.

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Polarographic Behaviour of Thorium (IV) in non Aqueous Medium.

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Investigation in non-aqueous medium is today one of the most attractive themes in polarography. Inorganic polarography in organic solvents is suited not only for the nalysis of such inorganic substances as are recipitated or hydrolysed in aqueous solutions, but also for the theoritical study of non-aqueous electrolyte solutions.

Acetonitrile, with a number of favourable solvent properties has been widely used in the past few year as a solvent for both inorganic and organic investigations. [1-14]

The determination of thorium (IV) by a direct polarographic method is difficult, the values of its half-wave potential being too negative to permit the recording of a wave before hydrogen. In one the direct methods of Graham and Larrabee, (15) m-nitro benzoic acid is used both as a polarographically reducible substance. Thorium has been also determined polarographically by Komarck (16, 17) by precipitation of thorium iodate and determination of the iodate ion. The method gives good results.

The auther has studied the reduction mechanism at the d.m.e. of thorium (IV) in non aqueous medium and their mixture. Since this aspect of the polarographic study has not been undertaken into consideration so far, it is worth while to study it.

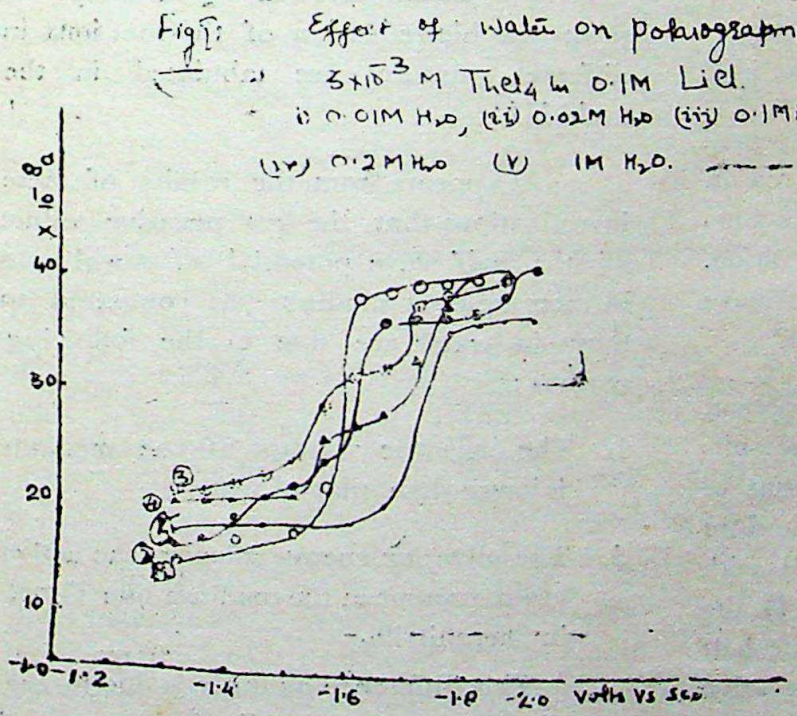
EXPERIMENTAL

Equipment:—The conventional Toshniwal (India) manual polarograph (CL02) and H cell with a S. C. E. were used. The capillary used in this work had the following characteristics : at 55cm. $t = 3.5$, $m = 1.50$ mg Sec^{-1} .

A glass electrode and a philips pH meter were used to measure pH. The oxygen from the solution was removed by passing through the solution, a stream of hydrogen. The reagents used were of analytical grade. A thermostate was used to keep the temp. Constant ($30 \pm .1$.C)

The cappillary charcteristics for different conditions at potential—1.60V vs. S.C.E.

Sl. No.	Strenth of EtOH used for O.1 M LiCl soln. v/v	Effective height Hg cm.	m mg./sec.	t drop time	$2/3$ $1/6$ m t
1:	10	38.28	1.52	3.94	1.65
2.	20	38.02	1.52	3.96	1.66
3.	40	38.28	1.49	4.02	1.65
4.	80	38 12	1.51	4.3	1 64



WORKING PROCEDURE

1.00 M solution of LiCl was prepared for diluting easily to 0.1 M and 0.5 M when required. 0.01 M solution of thorium nitrate wes used for diluting to the range under investigation.

Acetonitrile was allo wed to stand over calcium sulphate for four days, then decanted into a distilling flask and distilled. The distillate was redistilled. The distillate was kept in the receiving flask under an atmosphere of dry nitrogen.

The total water contant of the acetonitrile solutions was found by Karl Fischer titration. The polarographic solutions were used of 0.01 M concentration for two reasons, first to keep the ratio of water to metal ion as small as possible and secondly to use the solutions of approximately the same concentrations as employed by Kolthoff and Coetzce in their acetonitrile study.[18]

RESULTS

Thorium in alcoholic-water system—

Thorium in the range 10^{-3} to 5×10^{-3}M

in LiCl 0.1 M in 5°/₀ ethanol gives a polarographic wave increasing linearly with concentrations. The id/C values remains roughly constant with changing concentration. The half wave potential shifts to more negative values with increasing concentration. The slops of the graph, E vs log. i/id-i is very large in all cases.

In LiCl 0.1 M 20°/₀ ethanol, the diffusion current is related rectilinearly with concentration. The I values are almost constant with changing concentration. The behaviour of thorium in LiCl 0.1 M in 50°/₀ ethanol is the same as in the proceeding case, the diffusion current is proportional to concentration, but as before, the id corresponding to the initial value of C, seems to be somewhat less than normal. The id/C values are practically constant.

Similar behaviour was observed in LiCl, 0.1 M in 75°/₀ ethanol, id varies linearly with increasing thorium concentration. Some interesting polarographic results have been recorded in table (2).

Table (3) lists the half wave potentials for the reduction of thorium in acetonitrile medium. The effect of small amount of water on the reduction wave for thorium ion was found to be very pronounced with increasing water concentration (Fig. I) the waves are more irreversible and the half wave potentials are shifted to more negative values.

It is apparant from fig. that the potential at which thorium ion is reduced depends upon the relative degree of solvation of the ion by water and acetonitrile. As water displaces acetonitrile from the solvation sphere the half wave potential for the reduction of the metal becomes more negative tending to approach the values of aqueous systems. The shift of the second wave for thorium ion to more negative half wave potentials with increasing water concentration is, therefore, expected. Since the combined height of the waves remains constant, the electrode process taking place in the first step in the curves must involve transfer of the same number of electrons per mole of thorium as in the second step.

The total height of all the waves is the same even though the residual current for curves are large. The variation of the residual current was due to varying amount of oxygen in the solution. E_2^1 values for the polarographic reduction of thorium ions in different mixtures are tabulated in the table III.

It appears from the results of these investigations that the less negative values of the half wave potential of metal ions in non aqueous medium as compared to those in water are due to the following reasons :

1. The dielectric constant of the medium is lower than that of water.

2. The solvation energy is lower, the active group present in the medium like C≡N in acetonitrile.

This difference obiously is due to the contribution of the delocalized electrons of the acetonitrile. Current investigations show that when cations are added to this solvent new C≡N peak in the 2240-2275 cm^{-1} infra red region. The value of the new C≡N peak from that for the pure nitrile may then be regarded as a measure of the extent of solvent metal ion interection.

TABLE II

Polarographic characteristics of Th (IV) 3×10^{-3} M with changing concentrations of supporting electrolyte of different proportions of acetonitriles.

Sl.No.	aceto nitriler °/₀	pH	0.1M LiCl		O.5M LiCl		1.0M LiCl	
			id	E 1/2	id	E 1/2	id	E 1/2
1.	5.0	2.4	30.4	-1.5	25.0	-1.49	21.4	-1.49
2.	25.0	2.45	23.8	-156	19.0	-1.480	18.5	-1.46
3.	50.0	2.55	16·2	-1.48	12.0	-1.47	9.0	-1.44
4.	75.0	2.81	12.0	-1.46	10.0	-1.44	8.0	-1.42

TABLE III

Polarographic characteristics of Th (IV) 3×10^{-3} M in LiCl with changing temperature and effective height of the mercury column at different proportions of ethanol-

Sl.No.	°/₀Et OH	pH	Temp.coeffi cient of /degree.	Slope of the graph log. $h_{effective}$ vs. log. id.
1.	5.0	2.5	0.8	0.7
2.	25.0	2.55	1.4	0.65
3.	50.0	2.60	1.5	0.60
4.	75.0	3.0	1.3	0.55

Solvation of metal ions involves both acid-base (basicity) and ion-dipole interations. The dielectric constant of a medium, of course, governs the magnitude of ion-dipole interction. (The dielectric constant for acetonitrile EtOH is 37.5)

It appears the more postitive E1/2 values in acetonitrile probaby are result of smaller contributions of ion-dipole interection to the solvation energies. The results of these investigations strengthen the supposition made by Robert C. Larson and Iwamoto 17-18 that reduction of metal ions in nitrile solvent take place via a bridge mechanismi nvolving nitrile molecules in the coordination sphere of the coordination sphere of the metal ions.

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The Comparision of Arrival Rates with the Possion Distribution.

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In the present paper I have studied the queues and the behaviour of the customers at the Ration Shop at Agra. I took the data on different days and timings and their arrival times (i. e. when they join the system) is noted separately. This paper emphasizes on the dynamic human behaviour pattern not only of the individual but of the group. It is Sociological phenomena of group formation and group dynamic which depends on the interacting social relationship.

During the collection of data the Balking and Reneging behaviour of customers have been considered. The paper becomes very lengthy if I give the whole data collected on different days and timings. But even for the sake of clarification, I have given the chart of actual arrivals rates in the end of the paper.

Here I am comparing the arrivals rates with the poission distribution by forming groups. The first group consists of 16.8.65, 11.8.65, 4.8.65 & 18.10.65

$$\lambda = \frac{\text{Total numbers of all arrivals.}}{\text{Total numbers of all intervals.}}$$

(The intervals is of 10 minute i.e the number of arrival per 10 minutes. The numbers of arrivals per 10 minutest have been taken for the convenience.)

No. of arrivals x	No. of intervals observed with f	fx	Value from poission distribution $\frac{e^{-\lambda}\lambda^x}{\lfloor x}$	No. of ten Minutes interval observed with $e^{-\lambda}\frac{\lambda^x}{\lfloor x}$
0	4	0	.049787	2.838
1	11	11	0.149361	8.513
2	16	32	0.224042	12.770
3	9	27	0.224042	12.770
4	7	28	0.168030	9.577

5	2	10	0.100819	5.746
6	3	18	0.050409	2 873
7	1	7	0.021604	1.231
8	2	16	0.008102	0 461
9	0	0	0.002701	0.154
10	1	10	0 000810	0.046
11	0	0	0.000221	0.012
12	1	12	0.000055	0 001
Total	57	171		

Where $\lambda = \frac{\text{Total no. of arrivals}}{\text{Total no. of intervals}} = \frac{171}{57} = 3.00$

If any no. in the frequency column is small i.e. less than 5 It is desireable to group with the others to increase the sample size in the table given above. The frequencies for 5 to 12 arrivals are grouped together to yield the total frequency 10 and using the poission distribution. I complete the fourth column for values of x from the first column. This gives the probability for the indicated arrivals. After this we multiply each probability by the total frequency i.e. 57. I have the number of 10 minutes intervals expected to contain the indicated number of arrivals and I finally use the test.

$$\psi^2 = \sum_{i=1}^{5} (oi - Ei)i/Ei$$

$$= \frac{(15-11.351)^2}{11.351} + \frac{(16-12.770)^2}{12.770} + \frac{(9-12.770)^2}{12.770} + \frac{(7-9.577)^2}{9.577} + \frac{(10-10.523)^2}{10.523}$$

$$= 4\,092.$$

The tabulated value of ψ^2 for 4 degrees of freedom at 5% level of significance is 9.488 which is greater than the calculated value 4.092. Hence I concluded that the poission process is an acceptable fit statistically.

Now we shall see whether the group which consists of 12.8.65, 10.10·65 & 8.10.65 dates gives us a poission process which is an acceptable fit.

No. of arrivals x	No. of intervals observed with f	Fx	Value from poission distribution $\frac{e^{-\lambda}\lambda^x}{\lfloor x}$	No. of ten minutes intervalaccepted with $Ne^{-\lambda}\frac{\lambda^x}{\lfloor x}$
0	3	0	0.024724	1.187
1	4	4	0.091477	4.391
2	7	14	0.169233	8 123
3	7	21	0.208720	10.066
4	12	48	0.193066	9.267
5	6	30	0.142869	6.858
6	4	24	0.088102	4.229
7	3	21	0.046569	2.235
8	1	8	0.021538	10.033
9	0	0	0.008854	0.424
10	1	10	0.003276	0.157

$$\lambda = \frac{180}{48}$$

Where λ is same as defined previously.

$$\lambda = \frac{3.75}{}$$

I again group the observed frequencies which are less than 5 and apply the above formula. Thus

$$\psi^2 = \sum_{i=1}^{6} (Oi - Ei)_2 / Ei$$

$$= \frac{(7-5.578)^2}{5.578} + \frac{(7-8.123)^2}{8.123} + \frac{(7-10.066)^2}{10.066}$$
$$+ \frac{(12-9.267)^2}{9.267} + \frac{(6-6.858)^2}{6.858} + \frac{9-8.078)^2}{8.078}$$
$$= 2.41$$

The tabulated values of ψ for 5 degrees of freedom 5% level of signficance is 11.0707 which is greater than the calculated value 2.41. Hence I conciuded that the poission process is an acceptable fit statistically.

In the end I compare the total no. of arrival rates with the poission distribution.

No. of arrivals x	No. of intervals observed with f	fx	Value from poission distribution $\frac{e^{-\lambda}\lambda^x}{\lfloor x}$	No. of ten Minutes interval accepted with $Ne^{-\lambda}\frac{\lambda^x}{\lfloor x}$
0	19	0	0.097787	14 281873
1	29	29	0.149361	26 735619
2	36	72	0 224042	40.103518
3	31	93	0.224042	40.103518
4	24	96	0.168031	30.0777549
5	19	95	0.100819	18 046601
6	9	54	0.050409	9.023211
7	4	28	0.021604	3.867161
8	4	32	0.008102	2.450258
9	0	0	0.002701	1.483489
10	3	30	0.000810	0.137990
11	0	0	0.000221	0.039559
12	1	12	0.000055	0.010945

λ=Total no. of all arrivals/Total no. of intervals.

$= \frac{541}{189} = 3.02$

Again some numbers in the frequency column are less than 5. I combine the frequencies so that a number greater than 5 is obtained. In the above table frequencies for 7 to 12 arrivals are grouped together to yield a total frequency 12 and using poission distribution

I complete the 4th column. This will be the probability for the indicated arrivals. Column 5th is obtained by multiplying 4th column by the total frequency i.e. 179. I have the number of 10 minutes intervals accepted to contain the indicated number of arrivals.

$$\psi^2 = \sum_1 (oi - Ei)^2 i / Ei$$

$$= \frac{(19-14.281873)^2}{14.281873} + \frac{(29-26.735619)^2}{26.735619} + \ldots\ldots\ldots\ldots\ldots + \frac{(12-7.7989402)^2}{7.989402}$$

$$= 11.539.$$

Tabulated value for seven degrees of freedom at 5% level of significance is 14.067 which is greater than the calculated value 11.539. Hence I infer that poission process is an acceptable fit statistically.

Thus the results derived above I have concluded that arrival rates form the poission process and hence distribution is a poission distribution.

CHART OF THE ACTUAL ARRIVALS

Date	Session	No. of arrivals	F	M	M	R	P	Y	O	M
16.8.65	Morn	46	20	20	27	5	14	15	6	25
18.10.65	Even	34	14	20	15	10	9	20	6	28
11.8.65	Morn	54	33	21	21	3	30	33	5	16
4.8.65	Even	37	21	16	5	10	22	22	8	7
12.8.65	Morn	25	13	12	3	5	17	14	4	7
14.10.65	Even	34	14	20	9	12	13	20	3	11
8.10.65	Morn	53	28	25	20	12	21	34	7	12
8.10.65	Even	68	41	27	26	22	20	50	7	11
14.8.65	Morn	11	5	6	6	1	4	9	1	1
9.10.65	Even	40	22	18	15	16	9	25	3	12
10 10.65	Even	28	11	17	13	9	6	18	4	6
15.8.65	Morn	7	1	6	4	2	1	3	0	4
18.8.65	Morn	67	39	28	28	10	29	26	5	36
19.8.65	Even	37	19	18	23	4	10	8	7	22
Total		541	281	260	215	121	205	297	66	178

M = Males

F = Females

Status

M = Middle Class

R = Rich Class

P = Poor Class

Age.

Y = Young

O = Old

M = Middle.

Summary :

This paper is purely the case study. Here the behaviour of customers who come to get service, has been considered.

The Balking and Reneging behaviour of the customers has also been considered.

The actual arrival times of the customers on different days and in different months have been personally noted.

Then for different groups values from Poission Distribution for different ψ's and λ's from the table are noted.

Where $$\lambda = \frac{\text{TOTAL NO.OF ARRIVALS}}{\text{Total no. of all intervals.}}$$

Now I have the observed and expected frequencies ψ^2 test is applied, If the calculated value of ψ^2 is less than the tabulated value of ψ^2 at 5% level of significance, I concluded that arrival rates form the poission distribution. Thus on different groups applying the above procedure I saw that in all groups, Calculated value is less than the tabulated value. Hence the arrivals rates form the Poission distribution. This gives the comparision of arrival rates with the Poission distribution.

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CONTENTS

TEST OF INDEPENDENCE OF THE NO. ARRIVALS ON DIFFERENT DAYS & THE NO. OF ARRIVALS IN A CERTAIN INTERVAL AND EQUALITY OF PARAMETERS

B. B. SHARMA,
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INTRODUCTION:—

The subject of Queueing Theory, has developed rapidly in the recent years Several authors have worked out the queueing problems of one type of input under the varions assumptions regarding the arrival and service time distribution and the queue discipline.

Kendall has also introduced a few notations to represent a queueing process characterised by the poisson arrivals, general service time distribution and a single server by M/G/I. In this problem we have used this model. This problem is single ended queue problem involving queue of customers at a Ration Shop, bus station or Taxi stand, post office etc. In this paper data were collected at a Ration Shop where the customers (relating to Ration Shop materials) are served. In the present paper we are studying the correlation between the No. of arrivals on different days and the No. of arrivals in a cetain interval, say a interval of ten minutes. Then by assuming the arrival rates form poisson distribution which the author has shown in his previous paper. Here the author has shown that the number of arrivals in a certain interval is not independent and then he has shown that the observations have not come from the same poisson population. This paper is in continuance with the author's previous paper,

SOLUTION:-

Following formula is used to find the correlation coefficient from the following table No. 1.

$$\gamma = (\text{ Correlation Coefficient }) = \frac{\sum_{i=1}^{14} xi\,\gamma i - n\,\bar{x}\,\bar{y}}{\sqrt{\left(\sum_{i=1}^{14} xi^2 - n\,\bar{x}^2\right)\left(\sum_{i=1}^{14} yi^2 - n\,\bar{y}^2\right)}}$$

$$\bar{x} = (\text{ mean of the x Variate }) = \frac{541}{14} = 38.6428$$

TABILE NO. 1

X	Y	X_Y	X^2	Y^2
31	5.26	163.06	961	27.6676
54	2.57	138.78	2916	06.6049
25	1.92	48.00	625	03.6864
11	0.91	10.01	121	00.8281
7	0.88	6.16	49	00.7744
46	2.42	111.32	2116	05.8081
67	3.35	224.45	4489	11.2225
37	2.64	97.68	1369	06.9696
53	4.42	234.26	2809	19.5364
68	4.85	329.80	4624	23.5225
40	3.64	145.60	1600	13.2496
28	3.11	87.08	784	09.6721
34	3.77	128.18	1156	14.2129
34	3.35	113.90	1156	10.5625
Total 541	43.09	1838.28	24775	154.3176

$$\bar{y} = (\text{mean of the y Variate}) = \frac{43{\cdot}09}{14} = 3{\cdot}0778$$

Substituting in (1) Weget

$$\gamma = \frac{1838.28 - 14 \times 38.6428 \times 3.0778}{\sqrt{(24775 - 14 \times 1493.2660)}\ \sqrt{(154.3176 - 14 \times 9.4728)}}$$

$$= \frac{172.9128}{\sqrt{56961.7645}}$$

$$= .7335$$

RESULT--Since the correlation coefficient is positive and not zero, we infer that the number of arrivals on different days and the number of arrival in a cartin interval are positively correlated. In other words we can speak that they are not independent.

TABILE NO. 2

Now the problem arises of the equality of parameters.

Date	Total No. of Arrivals. X	Total No. 10 Minutes Intervals	No. of Arrival Per 10 Minutes Intervals	No. of Arrival Per Minute λi	$\mu i = \frac{\lambda i}{\Sigma \lambda i}$	$\mu i \Sigma Xi$	$(Xi - \mu i \Sigma Xi)^2$
14-8-65	31	6	5.26	0.526	.122	66.002	841.116
11-8-65	54	21	2.57	0.257	.059	31.919	487.570
12-8-65	25	13	1.92	0.192	.44	23.804	001.430
14-8-65	11	12	0.91	0.091	.021	11.361	000.130
15-8-65	7	8	0.88	0.088	.020	10.820	014.592
16-8-65	46	19	2.42	0.242	.055	29.755	263.900
18-8-65	67	20	3.35	0.335	.077	41.657	642.267
19-8-65	37	14	2.64	0.264	.061	33.001	015.992
8-10-65	53	12	4.42	0.442	.102	55.182	004.761
10-10-65	68	14	4.85	0.485	.125	67.625	000.140
9-10-65	40	11	3.64	0.364	.084	45.444	029.637
10-10-65	38	9	3.11	0.311	.072	38.357	119.946
14-10-65	34	9	3.77	0.377	.087	47.067	170.746
18-10-65	34	10	3.35	0.335	.078	42.198	067 207
Total	541	178	43.09	4.309			

We use the table No 2 to test whether the observations have come from the same poission population.

We know that the prob. of r independent poission variates can be written as the product of—

$$P(X_1 + X_2 \ldots\ldots\ldots\ldots\ldots\ldots\ldots\ldots + Xr) = \frac{-\Sigma\lambda i \quad \Sigma Xi \;/}{e \quad (\Sigma\lambda i) \;/ \;/(\Sigma Xi)\,!}$$

$$\text{and } P(X_1, \ldots\ldots\ldots\ldots\ldots\ldots\ldots, Xr / X) = \frac{(\Sigma Xi)\,!}{Xi\,!\,X_2 \ldots Xr\,!}\left(\frac{\lambda_1}{\Sigma\lambda i}\right)^{X_1} \ldots\ldots \left(\frac{\lambda r}{\Sigma\lambda i}\right)^{Xr}$$

The latter is the multinomial prob.

The present problem is of testing whether the observations have come from poission population is equivalent of testing whether the frequencies could have arisen from

a multinomial population with proportions $\mu i = \frac{\lambda i}{\Sigma \lambda i}$ so thet the X^2 with (r—1) i.e.

14—1=13 d.f. is $= \sum_{i=1}^{14} (Xi - \mu i \Sigma Xi)^2 / \mu i \sum_{i=1}^{14} Xi$

$$\frac{(841.116)}{=66.002} + \frac{(487.570)}{31.919} + \ldots\ldots\ldots\ldots\ldots\ldots + \frac{(67.207)}{42.198}$$

$$= 12.74 + 15.27 + \ldots\ldots\ldots\ldots\ldots\ldots + 1.59$$

$$= 63.29$$

The tabulated value of $X^2_{.05}$ for 13 d. f. is 22. 362 which is less than the calculated value 63. 29. Hence we infer that the observations could not have come from the same poission population.

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THE STRUCTURE OF NODE IN SAXIFRAGACEAE*

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INTRODUCTION

The vegetative anatomy of some plants of this family has been worked out by Thouvenin (1890), Sinnott (1914), Morvillez (1918), Watari (1939) and Swamy (1954). Sinnott (1914) examined the node of a few plants and indicated that the nodal structure is almost invariably tirlacunar. Swamy (1954) and other previous workers found both unilacunar and trilacunar nodes in the sub-family Escallonioideae. The present author in his earlier communication (Saxena, 1964) gave a passing reference about the nodal structure of **Saxifraga diversifolia.** This paper, however, gives information about the nodal structure or 13 saxifrage species.

MATERIAL AND METHOD

The material for the present study was collected from several places as follows:

Taxa	Place	Collector/s
1. **Saxifraga moorcroftiana** wall.	Badrinath, Kufri	Y. S. Murty M. R. Sharma
2. **S. californica** Nutt. ex Torr and Grey.	California	H. F. Copeland
3. **Mitella diphylla** L.	Chicago	Y. S. Murty
4. **M. pentandra** Graham.	California	H. F. Copeland
5. **Bistella dichotoma** (Murray) Bullock.	Madras	T. M. Varghese
6. **Ribes missouriense** Nutt.	Chicago	Y. S. Murty
7. **Deutzia staminea** R. Brown.	Chakrata	Y. S. Murty
8. **Whipplea modesta** Torr.	California	H. F. Copeland
9. **Hydrangea macrohylla** Ser.	Ootacumund	B. G. Menon
10. **H. Arborescens** L.	Chicago	Y. S. Murty
11. **Dichroa febrifuga** Lour.	Nepal	V. Puri
12. **Carpodetus serratus** Forst.	Centerbury (N. Z.)	B. A. Fineran
13. **Quintinia serrata** A. Cunn.	Centerbury (N. Z.)	B. A. Fineran

Following customary methods of dehydration the material was sectioned at 12-14 μ. The slides were stained with safranin-fast green or crystal violet-erythrosin combinations both of which gave satisfactory results.

OBSERVATIONS AND CONCLUSIONS

The nodal anatomy of thirteen species has been studied. On the basis of the anatomy, two types of nodes are distinguished; unilacunar 1--traced and trilacunar

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3--traced. The former type, i. e., unilacunar 1--traced is found in only three species viz. **Saxifraga californica** (Figs. 1—3), S. **moorcroftiana** (Figs. 4) and **Bistella dichotoma** (Figs. 8—12) all belonging to sub-family Saxifragoideae. However, the three species also show remarkable differences among themselves.

In **Saxifraga californica,** in the sub-nodal region, a leaftrace alongwith two branch traces, separates from the main vascular supply of the stem leaving a single gap in the cylinder. At a higher level, the leaf trace diverges out into the leaf base while the two branch traces supply the axillary bud. The nodal structure of S. **moorcroftiana** resembles with S. **californica** but for that the single leaf trace immediately after its separation divides into three and subsequently into more bundle with in the leafbase. Thus in the two species of **Saxifraga** studies, the leaf trace arises conjointly with the axillary branch trace. In **Bistella dichotoma** leaf trace is broad and somewhat arc-like in transverse section. With in the base of the leaf this bundle gives out minute branches on either side. At certain nodes the leaves appear sub-opposite and hence their leaf traces are also given off almost simultaneously (Fig 12).

Such a condition has been described for many other genera and families and it has been concluded that this condition may have been derived through fusion of ancestral many traced condition (See Canright, 1955). The same appears to be true for **Bistella.**

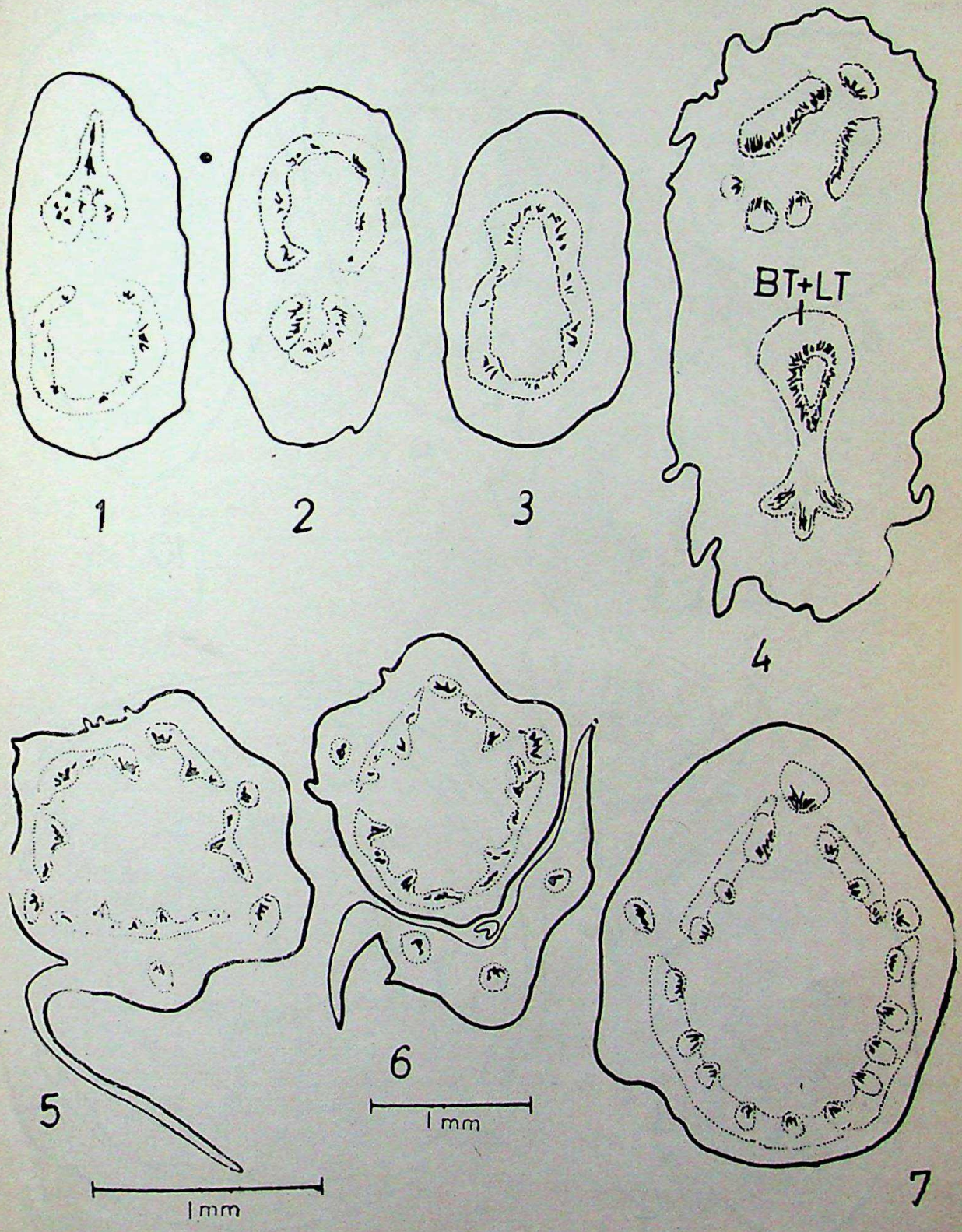
A trilacunar 3-traced node is seen in all other remaining species (Figs 5-7 and 13-27). Out of these three traces the median is more prominent than the laterals. In **Deutzia staminea** (Figs 14-17), in the sub-nodal region the vascular cylinder splits and gives off a median and two laterals on either side of the node. The median trace in this case too is quite prominent. The laterals spread with in the connate sheathing base and then meet with the median. A similar condition has been observed in **Dichroa febrifuga** as well (Figs. 23—24). The remaining species are just similar to these two except for the fact that their laterals do not fuse with the median. They continue branched or unbranched.

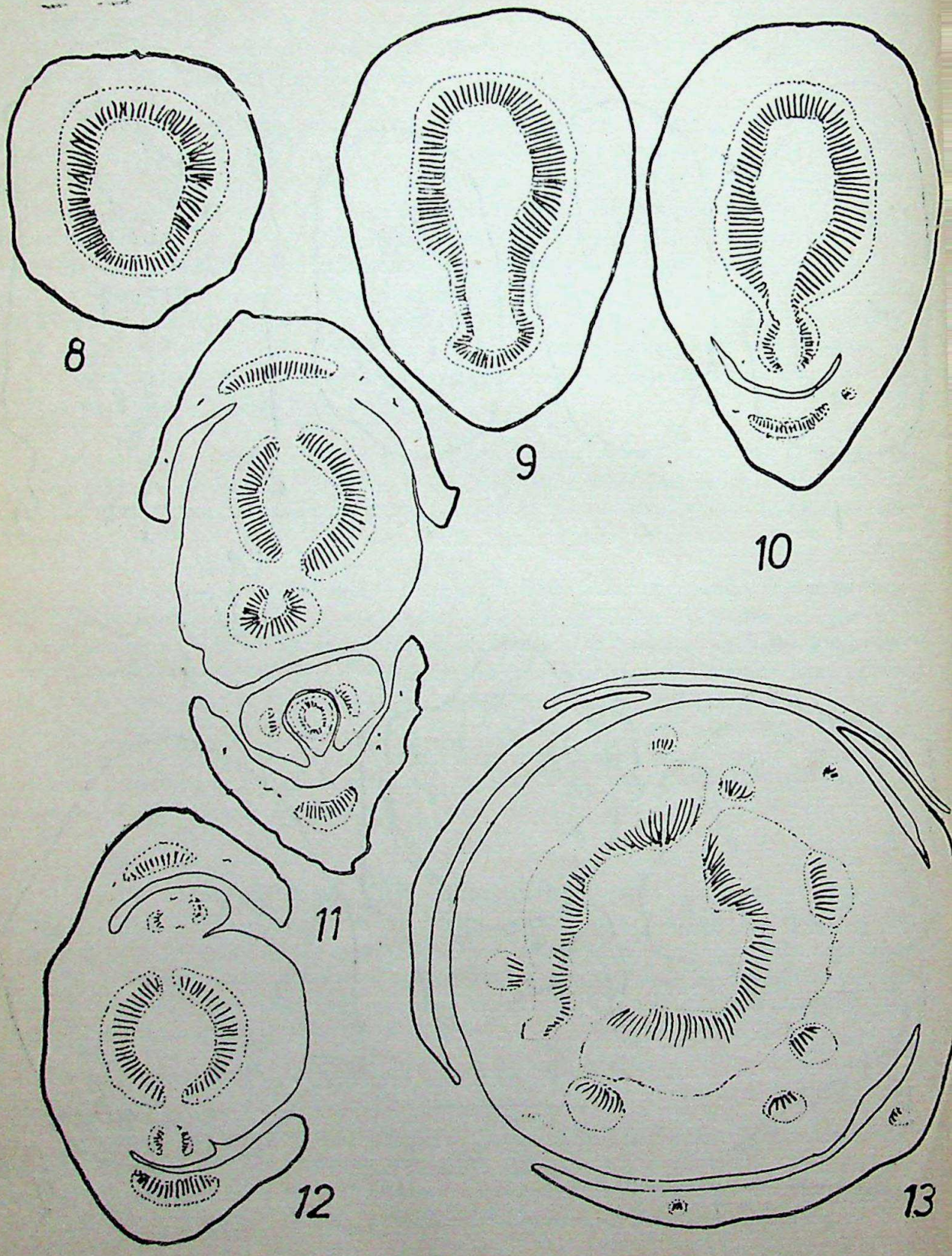
SUMMARY

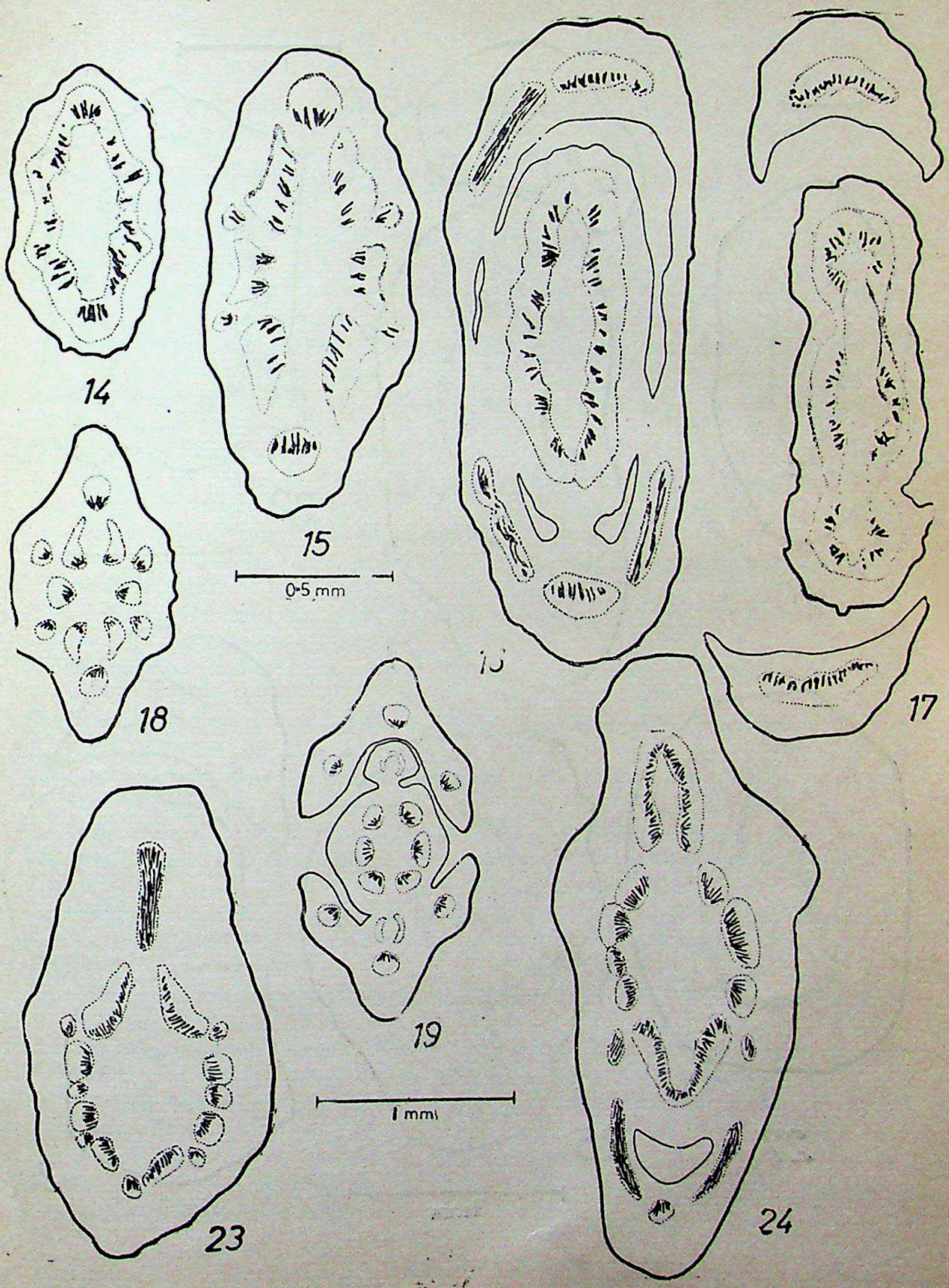
The members of the family Saxifragaceae exhibit generally a trilacunar nodal structure. In **Saxifraga** where the node is unilacunar the single leaf trace arises conjointly with the supply of the axillary branch. On the other hand, the single leaf trace in **Bistella** is broad and somewhat arc-like. Such a condition may have resulted by the fusion from many traced condition. In some cases viz. **Deutzia staminea** and **Dichroa febrifuga** the laterals fuse with the median.

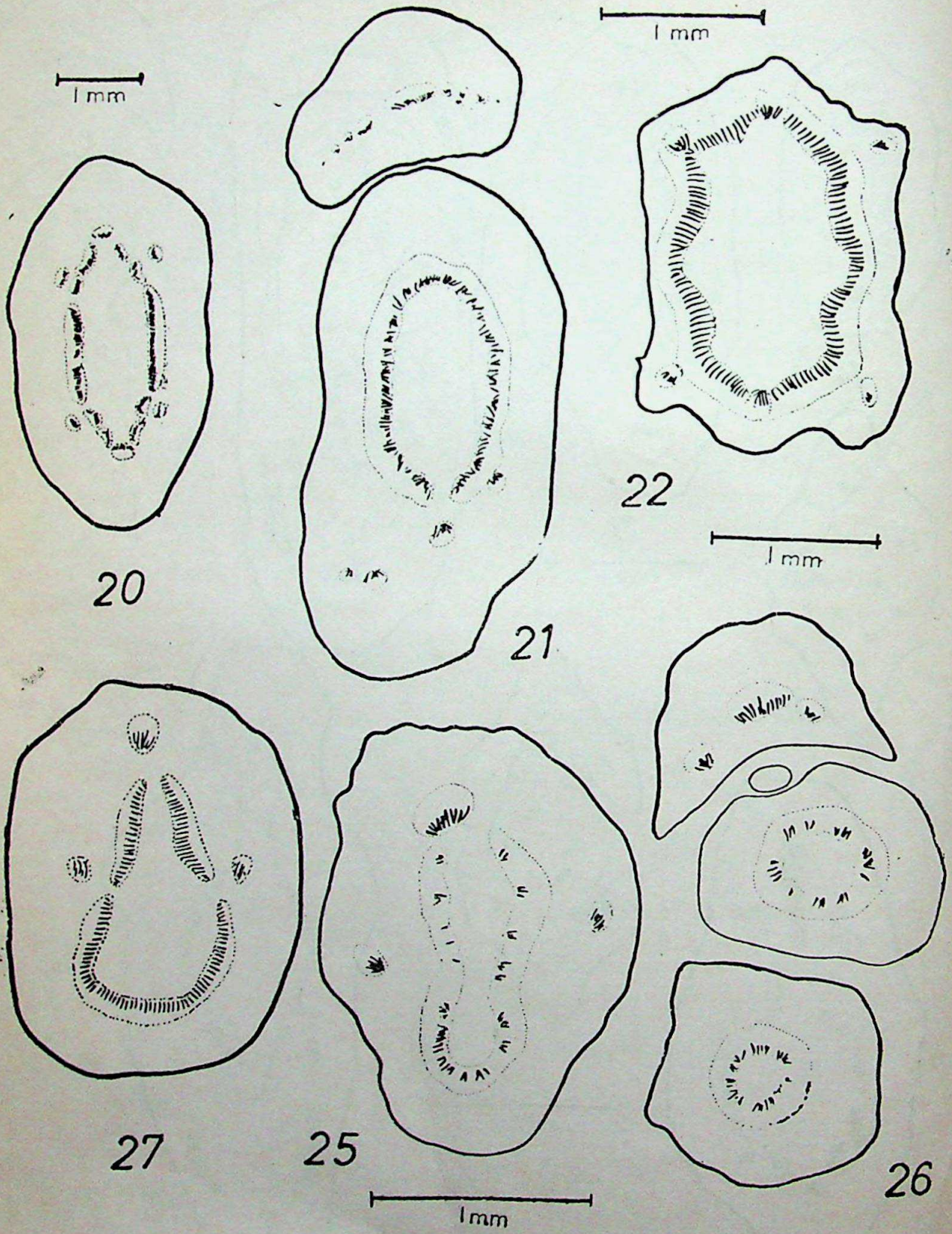
ACKNOWLEDGEMENTS

The author wishes to acknowledge his gratitude to Dr. Y. S. Murty and Professor V. Puri for their guidance and going through the manuscript. He is also thankful to all those gentlemen who helped in supplying the material for the present study and to the Govt. of India, Ministry of Education for financial assistance.









ALGAL FLORA OF DEHRADUN II. CHLOROPHYCEAE*

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SYSTEMATIC ENUMERATION

Carteria polychloris Pascher. Cell 10.5μ broad, 21—28μ long. In puddle, Rispana river bed, August 1968.

Chlamydomonas angulosa Dill. Cell 10.5—14μ long, 7μ broad. In puddle, Rispana river bed, August 1968.

Eudorina elegans Ehrenb. Colony 14μ in diameter, cells 6μ in diameter. In puddles, Clemen Town, August 1968.

E. illinoiensis (Kof.) Pascher. Colony 31.5$\times$35μ, cells 9μ in diameter. In puddle, Clemen Town, August 1968.

Pandorina morum (Mull.) Bory. Colony 12$\times$18μ, cells 4.5$\times$6μ. In puddle, Kalanga monument, August 1968.

Pleodorina californica Shaw. Colony 105$\times$110μ, bigger cells 17μ in diameter, smaller cells 8μ in diameter. In puddle near Welham Girls College, September, 1969.

Tetraspora apiocysteoides Chowdary, Suryanarayana et Sarma. Cells 4.2μ in diameter. Attached on rocks, Mohund, September 1968.

T. limnetica West. Cells 7$\times$8μ, generally two at one place. Attached on rocks, Asarori, September 1968.

T. cylindrica (Wahlenb) Ag. Cells 7$\times$10.5μ placed equidistantly. Attached on rocks, Sahastradhara, October 1968.

Palmella miniata (Leibl.) Chod. Cells 24.5—35μ. Attached on moist walls, Water works, October 1968.

Characium augustum A. Br. Cell 15—21$\mu\times$70—85μ. Epiphytic on Spirogyra, in puddles, Kalanga monument, August 1968.

Chlorococcum infusionum (Schrank) Meneghini. Cells 15—22μ in diameter. On soil, 20—Pritam road, August 1969.

C. vitiosum Printz. Cells 16—24μ in diameter. On soil, Rispana river, August 1969.

Chlorella vulgaris Beijerink. Cells 4—7μ in diameter. On soils, 20—Pritam road, August 1969.

C. conductris Bejerink. Cells 3—4.5μ in diameter. On soil, Rispana river, August 1969.

Selensastrum gracile Reinsch. Cells 3.5—5μ broad, 14—31.5μ long. In pond, Tea State, September 1969.

Sorastrum americanum (Bohlin) Schmidle. Cells 7—21μ broad, 5—21μ long. In pond, Tea State, September 1969.

Characiosiphon rivularis Iyengar. Thallus upto 15mm.; cells 12—16μ in diameter, often with two pyrenoids. Attached on stones, Rispana river, September 1969.

Hydrodictyon reticualatum (Linn.) Lagerheim. Cells 100 1260μ. In puddle, Dak pathar, August 1968.

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*This is the second communication in series on the algal flora of Dehra Dun, dealing with members of the Chlorophyceae.

Gloeotilopsis plantonica Iyengar et Philipose. Filaments 3.4μ broad, 11.5μ long. In pool, Dak pathar, August 1968.

Hormidium flaccidum (Kutz.)A. Br. Filaments 7μ broad; cells 21μ long. On moist soil, Sahastradhara, August 1968.

H. subtile (Kutz.) Heering. Filaments 5.5μ broad; 17μ long. On moist rocks, Sahastradhara, August 1968.

H. scopulinum (Hazen) Smith. Filaments 3.5μ broad; cells 24.5μ long. On moist soil, Botany Department, November 1968.

H. fluitans (Gay) Heering, Filaments 7μ broad; cells 12.5μ long. On moist soils, way to Badrinath, November 1968.....

H. dissectum (Gay) Chodat. Filaments 8.5μ broad; cells 12.5μ long. On mois soils, Rispana river, August 1968.

Schizomeris leibleinii Kutz. Uniseriate filaments upto 24.5μ broad; cells 5—10.5μ long. Multiseriate filaments upto 77μ broad, cells 21—24.5μ long. Epiphytic in pond, Tea State, October 1969.

S. indica (Ghose) Fritsch et Rich. Filaments 10.5μ broad; cells 3.5—7μ long. Attached on stones, Clemen Town, August 1968.

Ulothrix zonata (Weber et Mohr) Kutz. Filaments 24.5μ broad; cells 21μ long. Attached on stones, Kotidam, February 1969.

U. rorida Thuret. Filaments 14—15.5μ broad; Attached on stones, Rispana, August 1968.

U. tenvissima Kutz. Filaments 17.5μ broad; cells 10.5μ long. In slow moving water, Clemen Town, August 1968.

U. monoliformis Kutz. Filaments 11μ broad; cells 7μ long. In pool, Kalanga monument. August 1968.

Uronema elongatum Hodgetts. Filaments 5.5—7μ broad; cells 28—35μ long. In slow running water, Rispana river, September 1968.

U. terrestre Mitra. Filaments upto 3.5μ broad; cells 21—24.5μ long. On moist soil, Rispana, July 1968.

Cylindrocapsa geminella Wolle. Filaments 7μ broad; cells 17.5μ long; multiseriate filaments upto 31.5μ broad. In pool, Rispana river, Raipur, September 1969.

Cladophora crispata (Roth.) Kutz. Cells 84μ broad, 448μ long. Attached on rocks, Mossy fall, March 1969.

C. glomerata Kutz. Cells 70μ broad, 182—350μ long. Attached on snails, Sahastradhara, August 1968.

C. glomerata f. geniuna Kirch. Cells normally 35—70μ broad, 245μ long. Attached on stones, Dakpathar, August 1968.

C. glomerata f. callicoma Raben. Cells 42μ broad, 1960μ long. Attached on stones, Sahastradhara, August 1968.

C. glomerata subforma **kutzingiana.** Grunow. Cells 84—210μ broad, 210—217μ long. Attachced on iron-bars, Water works, November 1968.

Rhizoclonium implexum (Dillw.) Kuts. Cells 21μ broad, 63—70μ long. Attached on iron bars, Water works, November 1968.

R. hieroglyphicum (Ag.) Kutz. Cells 17.5—35μ broad, 94.5μ long. In puddles, Sahastradhara, August 1968.

R. riparium (Roth.) Harv. Cells 45.5μ broad, 52.5μ long. In pond, Asarori, October, 1968.

Pithophora oedogonia Wittrock. Cells 70—98μ broad, 350—1900μ long. In pond, September 1968.

Chaetophora elegans (Roth.) Ag. Cells 5—7μ broad, 10.5μ long. Epiphytic on aquatic grasses, Sahastradhara, August 1968.

C. incrassata (Hudson) Hazen. Cells 7μ broad, 31.5μ long. Attached on rocks, Deoband, September 1969.

Fritschiella tuberosa Iyengar. Rice-field Hardwar road, October 1968.

Stigeoclonium namum Kutz. Cells 5μ broad, 10.5—31.5μ long. On aquatic plants, Water works, November 1968.

S. falkandicum Kutz. Cells 7—10.5μ broad, 7—42μ long. Epiphytes in running streams, Dandalakhond, November 1968.

S. setigerum Kutz. Cells 7μ broad, 3.5—32. 5μ long. Attached on rocks, Sahastradhara, November 1968.

S. elongatum (Hassell) Kutz. Cells 10.5—14μ broad, 17.5 -- 24.5μ long. Attached on stones in running water, Kotidam, Novem ber 1968.

Microthamnion kutzingianum Naeg. Cells 3.5 -- 5μ broad, 10.5 -- 14μ long. On soil surface in rice-field, Nappani, November 1968.

Trenepohlia monile Wild. Cells 17.5μ broad, 43u long; sporangia 17.5μ broad, 24.5μ long. Attached on rocks, Deoband, October 1968.

Oedogonium autumnale Wittrock. Cells 10.5μ broad, 49μ long; oogonia 35μ in diameter, oospore 21μ in diameter; antheridia 5 -- 7μ long, 10.5μ broad. In puddle, Kalanga monument, August 1968.

O. fragile var. abyssinicum Hirn. Cells 14 -- 21μ long, 21μ broad; oogonia 35μ in diameter, oospore 27μ in diameter; antheridia 3.5μ long. Epiphytic, Dakpathar, August 1968.

O. terrestris Randhawa. Cells 14μ broad, 28μ long; oogonium 38.5μ in diameter, oospore 24.5μ in diameter; antheridia 5μ long.Terrestrial, 20-Pritam road, September 1969.

O. intermedium Wittrock. Cells 12μ broad, 52μ long; oogonium 35μ in diameter, oospore 24.5μ in diamter; antheridia 5μ long. Freefloating, Tea State, August 1969.

O. howardii West. Cells 7μ broad, 44.5μ long; oogoina 17.5×21μ, oospore 17.5μ in diameter; antheridia 5μ long. Epiphytic, Balbir avenue, October 1968.

O. dioicum Carter. Cells 35μ broad, 147.5μ long; oogonium 87.5×70μ, oospore 60.8 -- 64.5μ in diameter; antheridium 7μ long. In pond, Selakui, September 1968.

O. perfectum (Hirn.) Tiffany. Cells 14μ broad,49μ long; oogonia 31.5×35μ, oospore 31.5μ in diameter; androsporangia 7μ long; nannandria 3.5μ broad, 28μ long. In puddle, Kalangamonument, August 1968.

Bulbochaete elatior Pringsheim. Cells 14 -- 17.5μ broad,31.5 -- 42μ long; oogonia 35 -- 38μ broad, 35 -- 42μ long; oospore 28--35μ broad, 35--42μ long; androsporangia 7--10.5μ long; nannandria 7 -10.5μ broad, 14 -- 17.5μ long. In pond as epiphytic, Tea State, September 1969.

B. bharadwajae Singh. Cells 14 -- 17μ broad, 14 -- 21μ long; oogonia 28μ in diameter, ooospore 25μ in diameter; nannandria 28μ long; antheridia 7×10.5μ. On

submerged twig, Tea State, September 1969.

Oedocladium terrestris Randhawa. Cells 7 -- 10.5μ broad, 35 -- 63μ long; oogonia 28 -- 35μ broad, 49 -- 56μ long. On earth surface, 20-Pritam road, September 1969.

Debarya jogensis Iyengar. Cells 15.5 98μ; zygospores 35$\times$39μ. In pools, Rispana, August 1968.

Spirogyra condensata (Vaucher) Kutz. Cells 46$\times$105μ; zygospores 32$\times$60μ. In pond, Kalanga mounment, September 1968.

S. communis (Hassal) Kutz. Cell 24.5$\times$158μ; zygospores 21$\times$49μ. Dakpathar, August, 1968.

S. gallica Petit. Cells 63$\times$105μ; zygospores 52$\times$52-87μ. In pond, Dakpathar, August 1968.

S. biformis Jao. Cells 46.5$\times$47—70μ; zygospores 46.5$\times$47 -- 70μ. In pool, Asarori, October 1968.

S. spreeiana Raben. Cells 24.5$\times$115μ; zygospores 28$\times$56μ. In puddles, Dakpathar, August 1968.

S. jassiensis (Teodoresco) Cjurda. Cells 105$\times$140--175μ; zygospore 35$\times$125μ. Dandalakhond, November 1968.

Zygnema leiospermum De Bary. Cells 24.5$\times$24.5$\times$43μ; zygospores 24.5$\times$28μ. Terrestrial, 20-Pritam road, August 1968.

Z. normani Taft. Cells 28$\times$70μ; zygospores 42μ in diameter. In ponds, Kalanga monument, August 1968.

Z. mucigenum Randhawa. Cells 14$\times$98μ; zygospores 21$\times$31.5μ. In pond, 20-Pritam road, September 1968.

Z. collinsianum Trans. Cells 24$\times$43μ; zygospores 22.5μ in diameter. Rice-field, Clemen Town, August 1968.

Mougeotia genuflexa (Dillwyn) Ag. Cell 31.5$\times$84μ; zygospores 35μ in diameter. Rispana river, August 1968.

Sirogonium pseudofloridamum (Prescott) Trans. Cells 70$\times$264μ; zygospores 66.5$\times$112μ. Yamuna Canal, August 1968.

Sirocladium kumaoense Randhawa. Cells 56$\times$112μ; zygospores 52.5$\times$98μ. On moist rocks along Rispana river, August 1968.

Penium polymorphum Perty. Cell 21μ broad, 56μ long. As film in stream, Clemen Town, September 1968.

Closterium cornu Ehrenb. Cell 7 -- 10.5μ broad, 126μ long. In puddle, Kalanga monument, August 1968.

C. maliverianum De Not. Cell 63 -- 70μ broad, 450μ long. Free floating in a ditch, Koti, March 1969.

Cosmarium subbroomei Schidle. Cell 28 -- 35μ broad, 49 -- 53.5μ long; isthmus 10.5 -- 14μ wide. In puddle, Kalanga monement, August 1968.

C. margaritaum (Lund) Roy et Biss. Cell 56 -- 63μ broad, 77 --84μ long; isthmus 24.5 -- 28μ wide. In puddle, Clemen—Town, August 1968.

Arthrodesmus convergens Ehrenberg. Cell 42--49μ broad, 35 -- 47μ long; isthmus 14--20.5μ wide. In puddle, Raipur, August 1968.

Euastrum verrucossum Ehrenberg. Cell 63 -- 84μ broad, 77 -- 87μ long; isthmus 10.5 --

14μ wide. In puddle, Nalapani, July 1969.

Pleurotaenium coronatum (Breb.) Rabenhorst. Cell 42 -- 45.5μ broad, 436 -- 496μ long; isthmus 35 -- 38μ wide. In ditches, Clemen Town, August 1968.

Staurastrum gracile Ralf. Cell 42μ broad, 84μ long. Free floating in rice-fields, Hardwar road, September 1968.

S. cupidatum Breb. Cell 17.5 — 28μ broad, 21 -- 24.5μ long; isthmus 7 -- 10.5μ wide. Rispana river near lime factory, October 1969.

Dichotomosiphon tuberosus (A. Br.) Filaments 56μ broad; oogogonium 250μ in diameter; oospores 236μ in diameter; antheridia 56μ broad. In running water, Sahastradhara, August 1968.

Vaucheria aversa Hassal. Filaments 126μ broad; oogoina 210μ broad; oospores 70μ broad; antheridia 35μ broad. On moist bank of Rispana river, Sahastradhara, August 1968.

V. sessilis (Vauch.) De candolle. Filaments 70μ broad; oogonia 70—56μ; oospores 65 53μ; antheridia 28μ broad. On moist soil, D. A. V. College Botanical Garden, November 1968.

V. sessilis f. repens (Hassall) Hansgig. Filaments 56μ broad; oogonia 66.5—52.5μ; oospores65.5 × 52.5μ;antheridia 31.5μ broad broad. On moist places, Sahastradhara, November 1968.

V. sessilis varmajor (Smith.) Filaments 70μ broad; oognia 84 -- 112μ, oospores 73.5 × 98.5μ; antheridia 31μ broad. Attached on moist rocks, Mossy fall, March 1969.

V. sessilis forma **clavata** (Vaucher) Heering. Filaments 42μ broad; oogonia 56 × 84μ; oospores 52.5 × 83μ; On soil, Mossy fall, March 1969.

V. terrestris Lyngbe em. Walz. Filaments 56μ broad; oogonia 84 × 98μ; oospores 56 × 77μ; antheridia 14.5μ broad. On moist rocks, way to Mossy fall, March 1969.

V. walzi Rothert. Filaments 98μ broad; oogonia 70 × 98μ; oospores 65 × 84.5μ; antheridia 35μ broad. On moist soil, way to Dakpathar, August 1968.

Nitella accuminata A. Br. ex Wallm. Oogoina 296 -- 320μ broad, 400 -- 464μ long; oospores 216 -- 240μ broad, 200 -- 270μ long; antheridia 200 -- 240μ in diameter. In pond, Raipur, August 1968.

N. furcata (Roxb. ex Bruz.) Ag. em. R. D. W. Oogonia 176 -- 224μ broad. 224 -- 340μ long; oospores 160μ in diameter; antheridia 216 -- 224μ in diameter. In drainage, way to Mussorie, November 1968.

Chara vulgaris L., em R.D.W. Oogonia 400 -- 560μ broad, 520 -- 800μ long, oospores 375 -- 420μ broad, 550 -- 600μ long; antheridia 320 -- 440μ in diameter. In stagnent water, Sahastradhara, October 1968.

C. vulgaris f. contraria (A. Br. ex Kutz.) R.D.W. Oogonia 560 -- 575μ broad, 645 -- 680μ long; oospores 285 -- 320μ broad, 480 -- 525μ long; antheridia 400 -- 450μ in diameter In puddles, Robers Cave, February 1970.

C. globularis var. **virgata** (Kutz.) em R.D.W. Oogonia 280 -- 500μ broad, 480 -- 750μ long; oospores 240 -- 410μ broad, 360 -- 560μ long; antheidia 160 -- 320μ in diameter. In pond, Dakpathar, November 1968.

C. braunii Gm. R.D.W. Oogonia 280 -- 360μ broad, 440 -- 500μ long; oospores 240 --

325μ broad, 280 -- 365μ long; antheridia 235 -- 280μ in diameter. Yamuna Dam Site, November 1969.

SUMMARY AND CONCLUSION

The present communication deals with 100 species belonging to 48 genera of the chlorophyceae, recorded for the first time from Dehra Dun.

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STUDIES ON THE USE OF META-PERIODIC ACID AS AN OXIDANT FOR THE INVESTIGATION OF THE REACTION-MECHANISM OF XYLOSE.

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The reaction has been shown to be of the second order which appeared to be fastest at pH—8 and above. It has been shown that reaction taken place between xylose molecule and periodate-ion. The temperature coefficient was found to be of the order of 3.14 at for temperature range 30-35°C and the energy of activation was 42.37 K. Cals/Mole at PH∼2.

No work seems to have been done on the kinetics of the oxidation of xylose by periodic acid. The present investigation has been undertaken to determine the conditions for the stoichiometry of the reaction of xylose with periodate and to study its reaction-mechanism.

The reaction taken place as follows:—

$$CH_2OH\ (CHOH)_3\ CHO + 4H_3IO_6 \longrightarrow 4HCOOH + HCHO + 4OH^- - 4H_2O - 4IO_3^-$$

PROCEDURE:— The chemical employed were Analar products and were used without further purification.

To 25 ml of 0.025 N meta-periodic acid was added the requisite quantity of buffar solution. After 30 min. at constant temperature 25 ml of 0.025 N oxlose (kept at the same temperature) was added and Volume made up to 100 ml. The timer was started during the mixing. Sample (10ml.) were removed at known intervals. 25-30 ml. of 40% Sulphuric acid added together with 2-3 drops rutheniuna chloride and 5-6 drops ferroin, and the excess of periodate was titrated with o.oo5 N arsenite solution to a red end point.

REACTION RATE Graphs were plotted for all results and specific rates constants (K_1 first order reaction) fig.-I and (K_2 second order constant) fig.--II obtained from the slope of log (a-x) and 1/(a-x) respectively against time. The value. of K_2 thus obtained, is then multiplied by factor v/s where 'V' is the volume of the reaction mixture solution, this is the absolute value of K_2. In all graphs 'a' stands for the amount of periodate taken and 'x' for periodateconsumed in terms of the titre values of 0.005N arsenite solution required for 10ml. of the reaction mixture.

RESULTS AND DISCUSSION

In case of studies using excess of periodate at 30±0.1°c graphs was plotted of the values of log (a--x) Vs time in minutes (fig.--I) and a straight line was obtained. From the slope the value of K_1 was calculated and found to be 0.90×10^{-3} min.$^{-1}$ The above result showed that the order of the reaction with respect of xylose is one. The corro-sponding study with respect to periodate could not be conducted due to analytical difficulties. The over all order of the reaction was found to be two, which was confirmed by the results obtained on studies of second order constants using equivalent concentrations of reactants (fig.—II) where the straight line was obtained by plotting the value of 1/a-x against time in min. The temperature coefficient was found to be of the

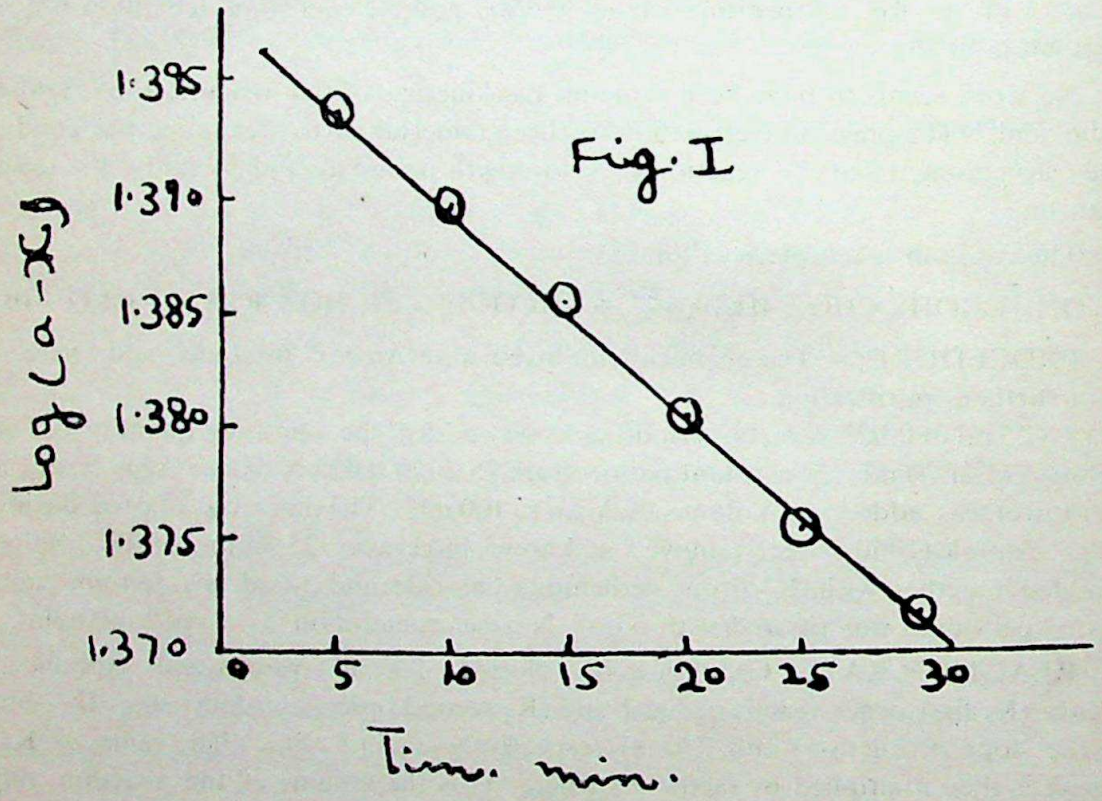
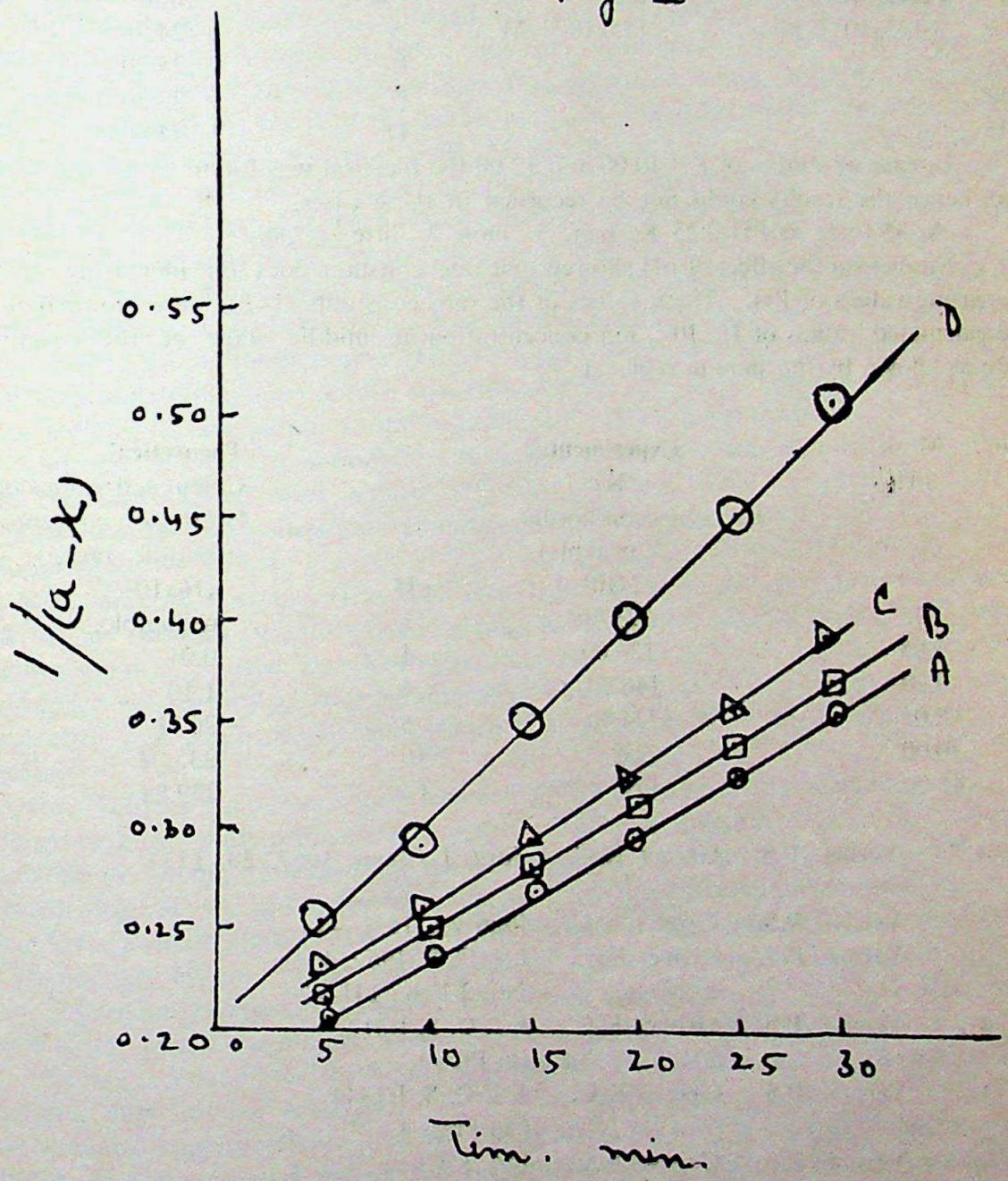


Fig. I

Fig. II



order 3.14 for the temperature range 30—35° C and energy of activation was 42.37 K. cals/mole at PH~2.

SECOND ORDER CONSTANTS AT 30±0, 1°C.
(FIG.II)

pH	Periodate	Xylose	Curve	min^{-1} $mole^{-1}$ Litre.
2.15	$3.125x10^{-3}$ M	$7.8125x10^{-4}$ M	A	24.76
3.95	,,	,,	B	25.20
6.30	,,	,,	C	29.36
8.05	,,	,,	D	44.80

In case of studies of PH 10.00 and 12.00 the reaction was found to be instantaneous and hence the results could not be recorded in these cases.

At 35 0.1°c at PH 2.25 K_2 $min.^{-1}$ $mole^{-1}$ litre=77.88

Studies on the effect of pH showed that rate constant goes on increasing with the increasing values of PH. These values of the rate constants (1--6) were compared with the calculated values of $H_3 10^{-}_6$ ion concentration at middle stage of the reaction at 25°c as shown by the date in table—I:

No.	Mean pH	Experimental K_2 (second order constants) $x2x10^4$.	pH	Theoretical Calculated values of $H_3 10^{-}_6$ ion concentration at middle stage. $x16x10^4$.
1.	2.15.	123.80	2	negligible.
2.	3.95	126.00	4	0.01
3.	6.30	146.80	6	1.10
4.	8.05	224.00	8	76.78
5.	10.00	fast	10	235.04
6.	12.00	fast	12	239.84

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ELECTROMETRIC AND SPECTROPHOTOMETRIC STUDIES OF COPPER (II) AND o—(p—TOLUENESULPHONAMIDO) ANILINE COMPLEX.

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Chem. Dept. University of Roorkee

Thanheiser and Maasen[1] reported the polarography of copper in ammonical medium but failed at low concentrations. Suchy[2] recommended a tartarate supporting electrolyte for the simultaneous determination of copper, bismuth, lead and cadmium. Lingane[3] has studied the effect of pH in this medium. At pH values below about 6.0, half-wave potential varies linearly with pH. Meites[4] has shown that the polarography of copper in citrate medium is analogous to that of copper (II) glycinate and copper (II) alaminate complexes has been investigated by Keefer.[5] Calvin and Bailes[6] have studied the polarography of salicyladehyde copper complexes.

o--(p-Tolyl sulfonoamido) aniline complexes of copper (II) have been extensively studied by Billman, Cowrkers[7], Joshi, Mahesh and Sharma[8], have used this reagent for the quantitative estimation of copper (II) over a pH range of 6.2--8.5. The copper chelate of o(p-Tolyl sulphonoamido) aniline when formed by the slow addition of the dilute reagent solution to an almost neutral solution of Cu (II) is green in colour.

Further Billman[7] mentioned that yellow colour chelate is formed by simply mixing the above ligand with copper (II) and pyridine. All these three components are necessary for the chelation—Elimination of any one results in no colour development.

The complex of copper (II) with o-(p-Tolyl sulphonoamido) aniline was studied. A red colour complex was obtained giving a maximum absorbance at 420 mu and a reduction wave at d. m. e. with half wave potential of -- 0.34 V. Vs S. C. E. structure of the complex was studied polarogrographically, Job's method slop ratio method, and Molar ratio and confirmed by amperometric titrations in 1:1 alcohol-water system.

Reagents:

o-(p-Toluene Sulphonamido) Aniline: It was prepared by reacting p--Toluene Sulphonyl chloride with o-Phenylenediamine. o-Phenylenediamine, 5 gms. (0.0.046 mol) was placed in 100 ml. three necked flask and dissolved in 30 ml. of pyridine. The flask was fitted with a stirrer and immersed in ice bath. p-Toluenesulphonyl chloride 9 gms was then added in a small portions at a time (2 hrs.) with stirring. The reaction micture was then poured into 60 ml. of ice cold water with vigorus stirring. A black oil settled out and the supernaut liquid was decanted. The oil was then taken up in a 1:1 mixture of ethanol-water, heated and norited, on cooling this solution the desired product crystallized out. It was recrystallized from 1:1 ethanol-water mixture yielding a white fluffy compound, m.p. 135-36, Analysis.

Standard copper (II) solution was prepared by dissolving copper nitrate (reagent grade), in 95% ethanol and the amount of copper was estimated by titration against hypo solution.

All organic reagents were employed as 0.02 M solution in 95% ethanol for the polarographic experiments. For spectrophotometry 0.002 M solution of the reagent was

Chem. Deptt. University of Gurukula Kangri; Hardwar

prepared in 95% ethanol. The concentrations were sufficiently low and evidently not susceptible to air oxidation. However as a precautionary measure the solution was stored in brown bottle and kept in a refrigerator when not in use.

Apparatus—

Absorbance measurements were made with a Bausch and Lomb Spectronic-20 Spectrophotometer. Conductivity measurements were made by Pye conductance Bridge Cat. No. 11700. A Toshniwal CL02 manual polarograph was used at a sensitivity 1/20, together with a water bath controlled at 25±0.1°C. The pH meter used was standardized at pH 4.0 as per instruction.

Previously the work on O (p-Toluenesulphonamido) aniline as gravimetric reagent for Cu (II complex was studied.[7] Billman and Charrin report the study of copper (II) ligand complex in presence of pyridine as one of the reactants. A complex is also formed without pyridene, this complex has been nursed by previous investigators. The present investigations are confined to the study of this copper complex polarographically, spectrophotometrically and by amperometric titrations.

Recommended Procedure:

Spectrophotometry: Standard copper (II) solution is transferred in suitable aliquot to a ml. measuring flask and 5 ml. of the ligand solution is added. It is then diluted to 25 ml. with 95% ethanol and shaked to ensure thorough mixing. It is kept for two hours and then transferred to spectrophotometer cell. Absorbance is then measured blank, which contains every thing but the Cu (II) ions.

Polarography: Ligand solution 20 ml. Cu (II) solution (O.02 M) followed by methyl cellulose 0.5 ml. (0.001%) are taken in a 25 ml. flask. It is diluted with 95% ethanol. An aliqot was then transferred to the polarographic cell de-oxygenated for at least 20 mts. and polarographed Vs. S. C. E. The procedure was repeated using different quantities of copper nitrate solution.

Results and Discussion

The o-(p-Toluenesulphonamido) aniline reagent, with copper (II) gives a brown-red colour complex of maximum absorbance at 425 mu (Fig, I a), which when treated with pyridine gives a yellow complex studied earlied by Billman and coworkers (loc-cit) giveng a maximum absorbance at 455 mu (b). Amino group of the reagent is not coordinating with copper (II) 7

Job's method was applied to study the complex formation between copper (II) and o (p-Toluene sulphonamido) aniline (Fig.II). The results were checked by slope ratio method, molar ratio method, conductometric titration and ratio of metal and chelating agent comes out to be 1 : 2 by both the methods. (fig. III, IV)

The reduction wave of o(p-Toluenesulphonamido) aniline is not well defined. On addition of copper (II) a well defined wave was obtained at about—0.8 V Vs. S.C.E. on addition of copper (II) ions the height of the wave is incresed, the increase being dependent on the concentration of copper (II). On changing the pH of the solution, the precipitation starts and a distorted wave appears in place of regular smooth wave. (Fig.V).

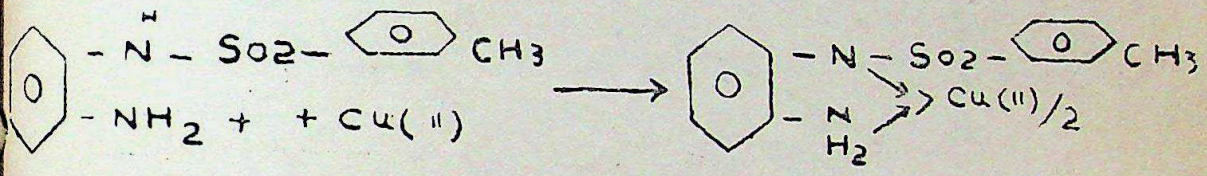
Effect of copper ion concentration on the diffusion current for the o(p-Toluenesulphonamido) aniline—copper complex at pH 6.8 is given in Fig. 5. The wave of the complex is reversible and is diffusion controlled, as diffusion current when plotted against the square root of mercury height gives a straight line. The value of n was calculated from the slope of log i/i d-i Vs. applied voltage after IR coppection and was found 1:2.

The equation:—

$$\frac{\triangle E1/2}{\triangle \log c} = \frac{-p}{n} 0{\cdot}0591$$

gives the value of p=2.

On comparing the results obtained by spectrophotometric polarographic methods, and amperometric (Fig.VI) titrations, the reaction can be expressed as follows :



This red complex reduces at the d.m.e. as follows:

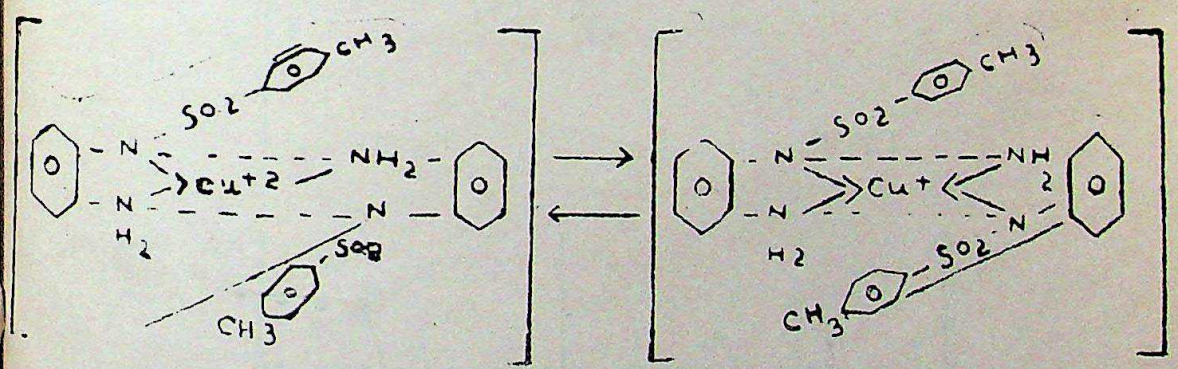


Fig. VI

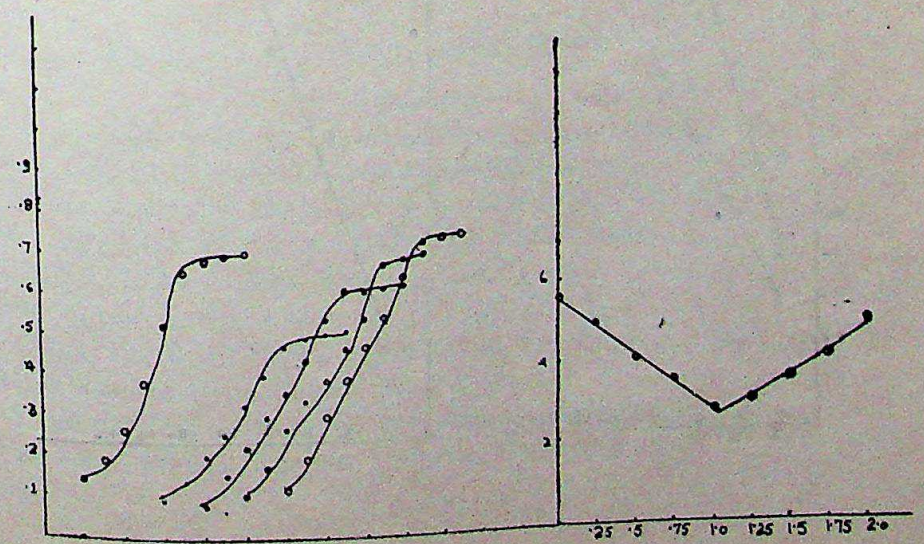


Fig. V

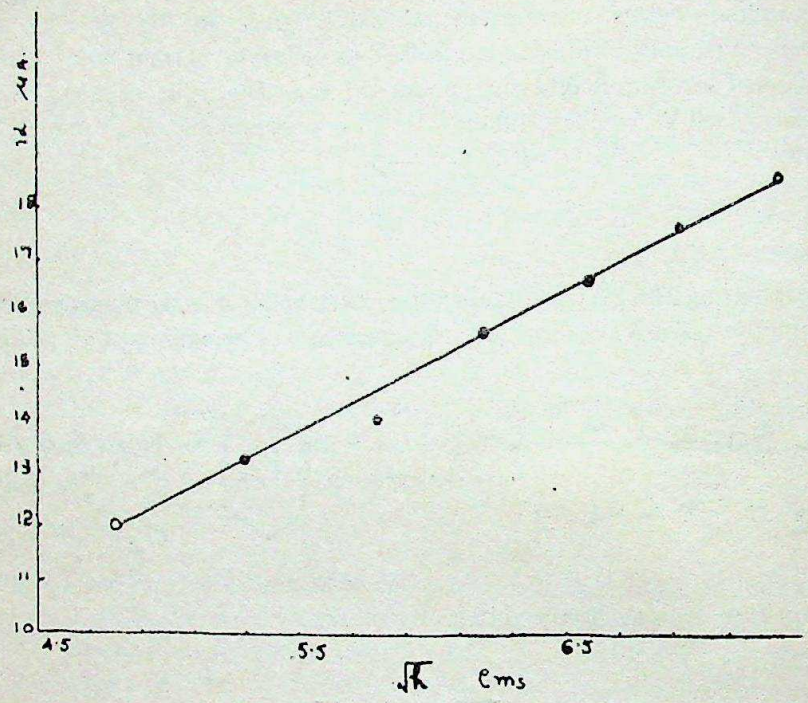


Fig. III

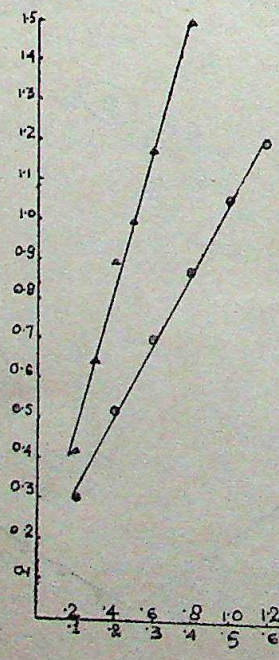
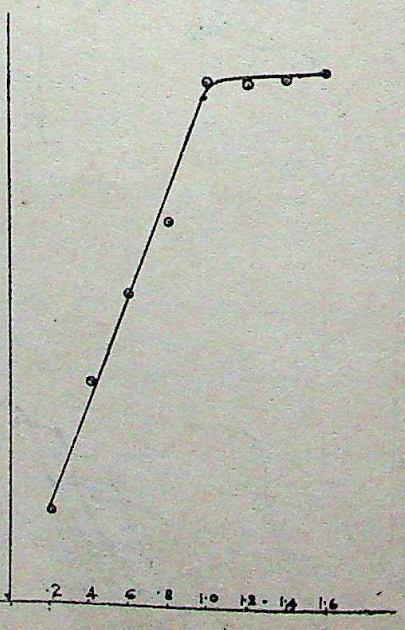


Fig. IV



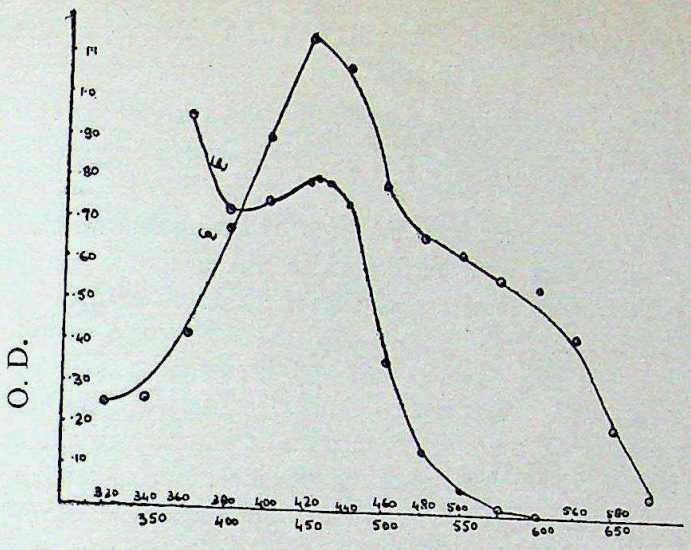


Fig. I m μ

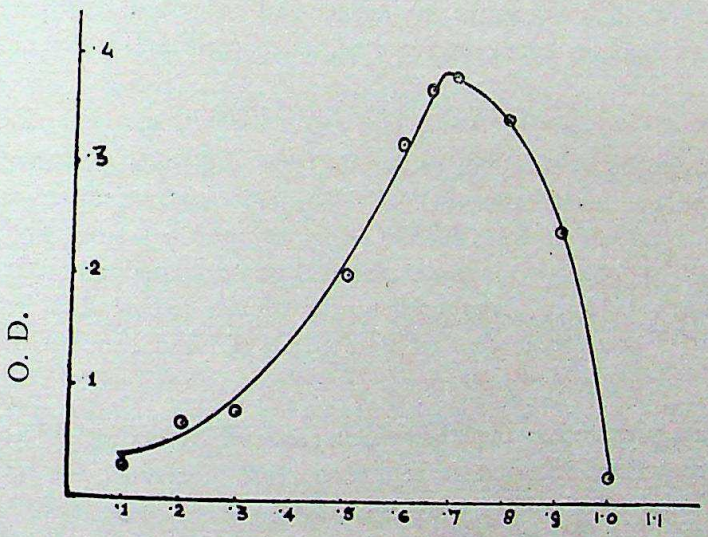


Fig. II motar fraction of metal

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BINARY MIXTURE OF PROTEIN AND SURFACTANTS AS EMULSIFYING AGENTS

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Various types of emulsions have been prepared by taking two immicible liquids as continuous and disperse phases and surface-active materials[1]. Naturally-occurring substances[2], and finely-divided solids[3] as emulsifying agents. In an earlier communication[4] studies on the preparation and properties of emulsions with single anionic, cationic and nonionic surfactants as emulsifying agents, water and keroseneoil as immiscible liquids have been reported. Another important aspect of the Chemistry of emulsions which has not been given due attention is the use of mixture of emulsifying agents for making emulsions. Previous investigation[5], deals with the physico-chemical studies of emulsions with binary mixture of surfactants (anionic+nonionic and cationic+nonionic) as emulsifying agents. In the present work, studies on the preparation and properties of emulsions with binary mixture of gelatin and surfactants (anionic+gelatin; Cationic+gelatin and nonionic+gelatin) as emulsifying agents and water and kerosene oil (K. O.) as external and internal phases have been reported.

EXPERIMENTAL SECTION

Gelatin (photographic quality) was prepared from calf hide as described earlier.[6] Sodium dioctyl sulphosuccinate (Manoxol-OT-MOT-anionic surfactant), Cetyl pyridinium bromide (CPB-cationic surfactant) were B.D.H. (England) products and Poly-oxyethylene sorbitan monosterate (Tween 60—nonionic surfactant) was obtained from M/s Koch-Light Laboratories Ltd, London. In all the experiments double distilled K. O. (b.p. 205°C and sp. gr. .7948925 at 30° C) and double distilled water (pH 6.2 and conductivity $.85 \times 10^{-6}$ ohm^{-1} cm^{-1}) were used.

Emulsions were prepared by Agent-in-water method[7] by taking different ratios of water and K. O. and fixed concentrations of mixture of emulsifying agents. To the aqueous solution of mixture of gelatin and surfactants, K. O. was added slowly with constant stirring which was subjected to homogenization by considerable agitation with the help of Braun Emulsifier. Emulsion Type was determined by the Dye Solubility Method[8]. Particle size was measured by taking photomicrographs of the photographic slide of the emulsion with the help of Carl Zeiss Jena Microscope fitted with attachment camera using 15x occular and 90x objective[9]. A typical photomicrograph (x 12150) of the emulsion stabilized by binary mixture of gelatin and anionic surfactant is shown in Fig. 1. Viscosity, specific gravity and surface tension of the emulsions were determined by the usual ostwald viscometer, pyknometer and drop weight methods respectively. pH and conductivity of the emulsions were measured by Beckman pH meter and conductance with 'magic-eye.'

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RESULTS AND DISCUSSION

The results obtained from the date are summarized in Tables 1, 2 and 3. During the preparation of emulsions, it was obtserved that when the quantity of K. O. used was more than that of water thick, viscous and concentrated emulsions were obtained which may be due to the fact that phenomenon of creaming occurred and rate of creaming was increased with the increase in concentration of oil. It may be seen from the Tables that there is a decrease in surface tension specific gravity and increase in viscosity, conductivity and particle size of the emulsions with a decrease in the continuous phase (water). Emulsions with minimum water content were found to be more stable. Thus low surface tension and specific gravity and high viscosity, conductivity and particle size favour emulsification and increase stability of oil-in-water emulsions. it was observed that the stability of emulsions prepared with mixture of gelatin and surfactants was greater than those made with single surfactant.[4] It may be attributed that complex formation takes place at the oil-water interface, the resulting interfacial film possesses greater strength and resistance to rupture; hence the emulsion droplets are less liable to coalescence and the emulsion more stable.

The structure of an O/W emulsion stabilized by binary mixture of gelatin and surfactants may be represented schematically accroding to "oriented wedge theory"[10] with the polar groups oriented towards the water phase and non-polar groups oriented towards the oil.

TABLE--1

EMULSIONS STABILIZED BY MIXTURE OF GELATIN AND ANIONIC SURFACTANT

Emulsion Type :— O/W; Gelatin = .05 g.; MOT = .05 g; K. O. = 10ml.

Emulsion No.	Water (ml.)	O/W Ratio	pHat 20 °C	Conductivity at 20°C ($X10^{-4}$ ohm^{-1} cm^{-1})	Particle Size (μ)	Specific Gravity at 30°C	Viscosity at 30°C ($X10^{-3}$poises)	Surface Tension at 30°C (dynes/cm)
1.	10	1:1	7.10	3.75	9-10	.8897915	45.69819	20.37442
2.	20	1:2	7.05	3.35	8-9	.9269484	13.04070	22.08922
3.	30	1:3	7.00	3.00	8-8	.9455592	10.24071	23.28987
4.	40	1:4	6.95	2.70	6-7	.9561108	9.39471	24.37034
5.	50	1:5	6.95	2.45	5-6	.9632314	9.03427	25.43586
6.	60	1:6	6.90	2.20	5-5	.9681835	8.64784	26.27538
7.	70	1:7	6.90	2.00	3-4	.9727472	8.47171	27.15476
8.	80	1:8	6.85	1.80	2-3	.9763399	8.28503	27.78440
9.	90	1:9	6.85	1.65	1-2	.9791558	8.19946	28.41579
10.	100	1:10	6.85	1.55	1-2	.9808065	8.14798	28.74996

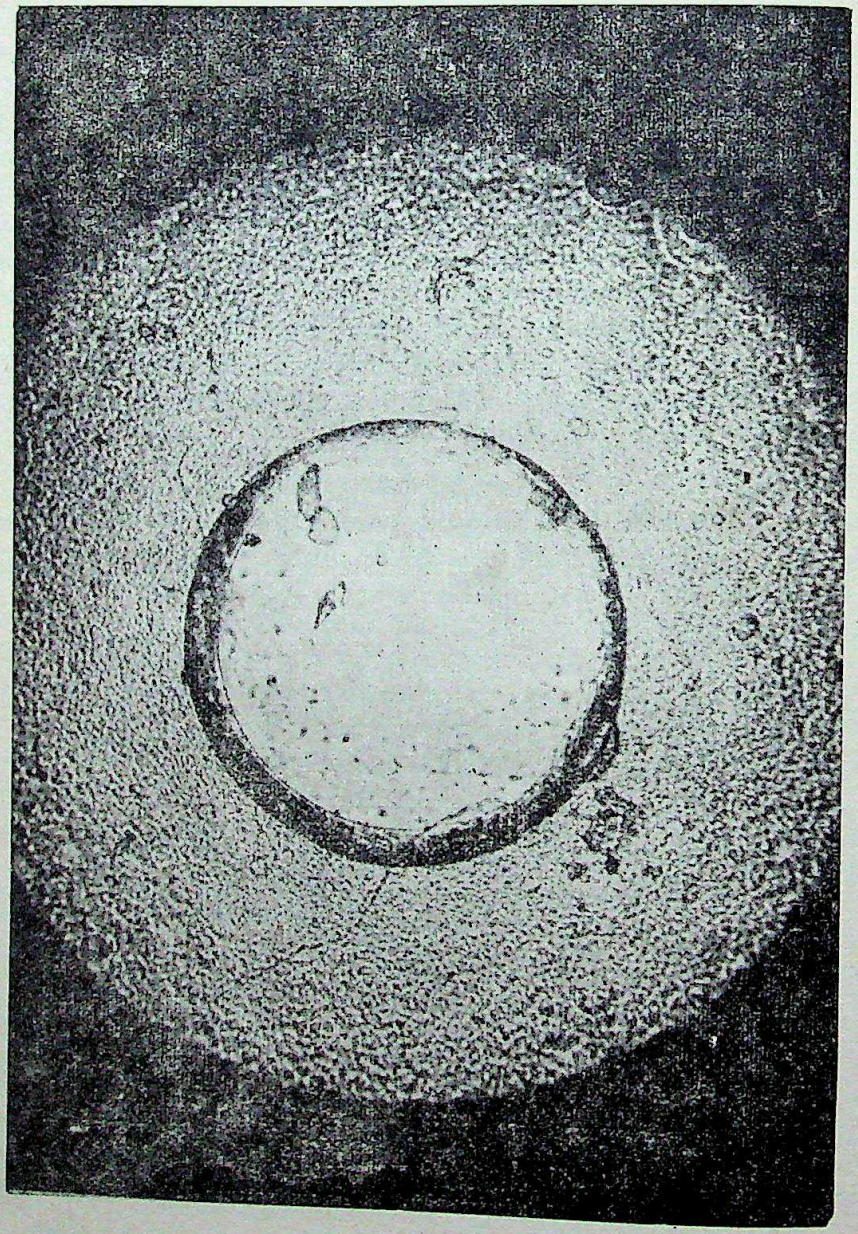

Fig. 1

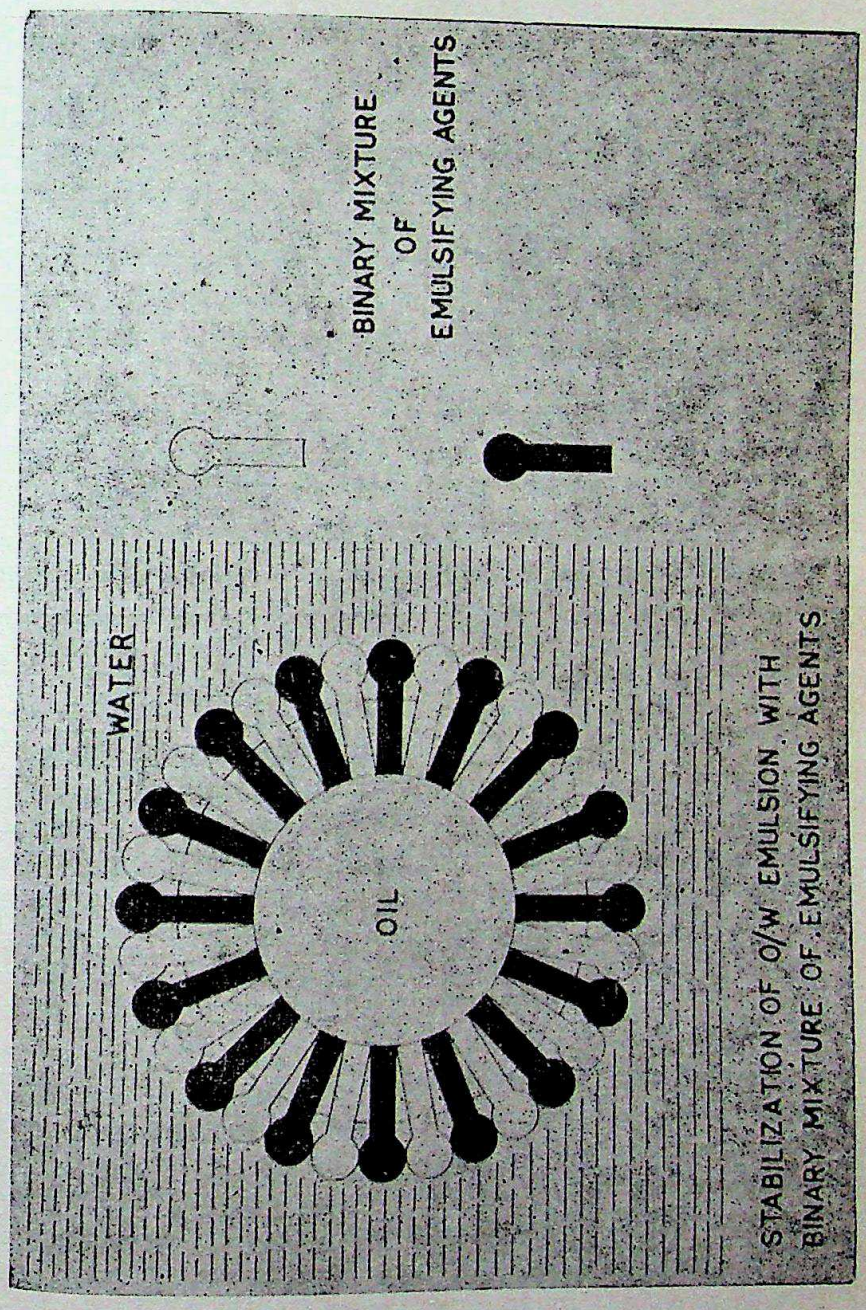

Fig. 2

TABLE—2

EMULSIONS STBILIZED BY MIXTURE OF GELATIN AND CATIONIC SURFACTANT

Emulsion Type:— O/W; Gelatin = .05 g.; CPB=.05 g.; K. O.=10 ml.

1.	10	1:1	5.80	2.65	8-9	.8869109	47.33693	21.84651
2.	20	1:2	6.00	2.40	7-8	.9259127	14.47403	23.80753
3.	30	1:3	6.20	2.15	6-7	.9438114	1085462	25.15035
4.	40	1:4	6.40	1.95	5-6	.9541040	9.52419	26.13761
5.	50	1:5	6.50	1.80	4-5	.9612894	9.07990	27.09174
6.	60	1:6	6.60	1.70	3-4	.9666947	8.76394	27.77795
7.	70	1:7	6.65	1.60	2-3	.97132331	8.52457	28.47149
8.	80	1:8	6.70	1.55	2-3	.9750129	8.31755	28.86838
9.	90	1:9	6.75	1.50	1-2	.9779583	8.23309	29.24974
10.	100	1:10	6.80	1.45	1-2	.9796413	8.20366	29.60267

TABLE—3

EMULSIONS STABILIZED BY MIXTURE OF GELATIN AND NONIONIC SURFACTANT

Emulsion Type:— O/W; Gelatin=.05 g.; CPB=.05 g.; K. O.=10 ml.

1.	10	1:1	6.70	11.10	7-8	.8900828	46.70737	24.84579
2.	20	1:2	6.70	9.55	6-7	.9271426	13.87167	26.38413
3.	30	1:3	6.65	8.30	5-6	.9475336	10.79138	27.49860
4.	40	1:4	6.65	7.25	4-5	.9580851	9.52035	28.36508
5.	50	1:5	6.65	6.20	3-4	.9654000	9.07646	29.17353
6.	60	1:6	6.60	5.30	2-3	.9708052	8.75867	29.64253
7.	70	1:7	6.60	4.55	2-3	.9753042	8.51612	30.09336
8.	80	1:8	6.60	4.00	1-2	.9789940	9.32894	30.52573
9.	90	1:9	6.60	3.70	1-2	.9821659	8.24651	30.78925
10.	100	1:10	6.60	3.55	1-2	.9836548	8.19320	31.00206

ABSTRACT

Binary mixture of protein (gelatin) and anionic, cationic or nonionic surfactants as emulsifying agents and water and kersene oil as continuous and disperse phases have been employed for the preparation of oil-in-water emulsions. Properties like emulsion type, specificgravity, surface tension, viscosity, conductivity, pH and particle size of these emulsions have been measured. Emulsions with low surface tension and specific gravity values and high viscosity, conductivity and particle size values are more stable.

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MARRIAGE FLIGHTS OF TWO SPECIES OF THE ANT GENUS *HOLOCOMYRMEX* MAYR IN GURUKULA KANGRI HARDWAR.

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INTRODUCTION

The study of marriage flights of ants, as of other social insects like bees and wasps is important and interesting; important because the flights lead to ecological and geographical distribution (Kannowski 1959) and interesting because every species has got its own range of ecological factors for its flights (Gupta 1970). The usefulness of this aspect of the ant study has been very well realised by a number of workers in the foreign countries who have made useful observation on the marriage flights of different ants with special reference to their relationship with temperature, light, humidity, rains and wind. A few names worth mentioning are: Haskins and Haskins (1951), Way (1954), Chapman (1954, 1957), Brian and Brian (1955), Talbot (1956, 1959, 1963, 1964, 1966, 1968), Barnes and Nerney (1957), Kannowski and Kannowski (1957), Collingwood (1958), Kannowski (1959a, 1959b, 1962, 1969), Anderson and Kannowski (1960) and Scherba (1961). Unfortunately however, the study of marriage flights of ants seems to have suffered badly neglected in India where the work done is only very scanty. Ayyar (1937) recorded some observations on marriage flights of *Camponotus compressus fabr* and Gupta (1970) did the same on those of *Myrmecocystus setipes* Forel as well as *C. compressus*.

This paper presents the results of studies carried out on the marriage flights of two species of ants i. e. *Holocomyrmex scabriceps* Mayr and *Holocomyrmex criniceps* Mayr in the campus of Gurukula Kangri Vishwavidyalaya, Hardwar, Uttar Pradesh, India, during 1969.

DESCRIPTION OF THE LOCALITY

Gurukula Kangri Vishwavidyalaya is situated on the left bank of the Upper Ganga Canal at a distance of about four kilometers to the South West of Hardwar railway station, Hardwar itself lies within the sub-tropical region (Lat. 29°58'N, Long. 78°13'E) at an altitude of 294 meters above sea level and stands on the right bank of the river Ganga at the foot of the Siwalik Range. A detailed description of the locality under observation has been given by Gupta (1968).

DEFINITIONS

The following terms and their definitions have been adapted from Kannowski (1959).

Flight Duration—This is the length of time for a flight from a single colony of a species in a given area.

Flight Season—This is time interval during which flights of a species occur in a given area. It extends from the date of the first flight to the date of the last flight.

Size of Flights—The size of flight population was estimated on the basis of five or six random counts of the alates taking flight from the nest per minute. An average of 5 to 40 alates flying per minute has been taken as characteristic of a moderate flight.

ECOLOGICAL DATA

The exact data on temperature and relative humidity for the observation period 1969 were obtained from the Meteorological observatory at Bahadrabad situated at a distance of about eight kilometers South-west of Hardwar.

The standards fixed for the ecological factors are as follows:—

Sky conditions—cloudy; partly cloudy; hazy.

Wind—calm; slight.

Light intensity—poor; dim.

HOLOCOMYRMEX CRINICEPS

H. criniceps is vegetarian and harvester in nature. It is fairly common in the locality under study, distributed all over the meadows and open grass fields. It is mostly present in places covered with low vegetation but the population thins out on bare grounds and in tall and dense vegetation. The important factor in its distribution is that it always has the seeded vegetation in its neighbourhood for the harvest. The nests are incomplete craters with elliptical or crescentric shape, always with a single opening. The ant possesses all the typical seed collecting habits.

Five flights were recorded. Their dates as well as durations are mentioned in table 1. Their climatological range is given in table 2. The flight occurring on 11.7.69 was observed rather more fully. Important facts concerning the same are recorded in table 3. A description of observations on the process of flight and its weather conditions follows.

Activity of the workers before the Emergence of alates—Before the emergence of alates an extraordinary activity of the workers was noted. They had left foraging and had gathered in abnormally large numbers around the nest hole. When approached they were found to become alert and when touched became aggressive, biting severely at the hands and feet of the author, as well as spreading over his body in great numbers.

Emergence of the alates—Emergence of alates was initiated by males. All of a sudden a heavy rush of males was out of the nest within two minutes and this rush appeared like a rapidly flowing stream of winged individuals. No female was noticed alongwith the male stream but the females soon followed the last male without any break and very soon a number of them also appeared all around the nest. When the alates were approached for collection rhey were badly disturbed and they tried to go back inside the nest but were not allowed to do so by their workers guarding the nest opening. An outward stream of the females continued for five minutes only.

Alates taking positions for flight—Now the alates before being air-borne prepared themselves for the flight. Nearly all of them climbed up the stems and leaves of grass where they took rest for three or four minutes and then they fluttered their wings for a few seconds. The males on

coming in contact with the females, became too passionate to get upon the backs of the females awkwardly enough even from anterior and lateral sides, in addition to the usual posterior one. There was however, no copulation in this position. The two sexes continued making contacts and separating from each other again and again in this way.

Flight—Males took initiative in flying also which were soon followed by the females and after that both the sexes continued their flight. During the initiation of the flight, workers also were seen to be very active in that they stimulated the alates for flight by touching their bodies. The whole process of flight lasted for approximately twelve minutes. After the flight only three males were left behind on the ground and tried their best to retire to their nest but were not allowed entry by the workers. It was probable that they were crippled in some way or the other and hence were not able to accompany their fellows.

Weather conditions—A heavy rain-fall was recorded in the morning. Nearly throughout the day the sky remained cloudy but at the time of flight the sky was only hazy. As it was sun-set the light intensity was poor but gradually growing to be dim. There was a slight eastern wind.

HOLOCOMYRMEX SCABRICEPS

This species also is very common on the campus of Gurukula Kangri Vishwavidyalaya. Its distribution; nesting and general habits are nearly similar to those of **H. criniceps** and have been described by Rothney (1889).

Three flights were recorded. Their dates as well as durations are mentioned in table 4. Their climatological range is given in table 2.

The flight on 30.6.69 was observed in detail which are nearly the same as in **H. criniceps.** The sky was partly cloudy throughout the day. There was a heavy rain-fall from 10.35 A. M. to 11.15 A.M. It was the first rain of season marking the break of monsoon. The light intensity was dim and the wind was noted as calm.

DISCUSSION AND CONCLUSIONS

Marriage flight is one of the most important and vigorous life activity of the social insects and therefore a high temperature is favourable. The fact has been very well established by the records given above in which the temperature ranges of marriage flights of the two species of ants under study are respectively 24.8° C to 31° C and 26.5° C to 30.1°C. Observations and conclusions of Talbot (1956, 1963, 1966, 1968), Champman (1957), Anderson and Kannowski (1960), and Gupta (1970) on the marriage flights of the species studied by them confirm the conclusions arrived here at, as the temperature ranges of flights in the works of these authors have been between 15° C to 38° C.

Intensity of light suitable for flights is rather a specific affair different in different species. For some species low intensity (Kannowski and Kannowski, 1957; Gupta, 1970) while for others high intensity of light (Talbot, 1963, 1964, 1966, 1968, Gupta, 1970) has been found favourable. In the present case poor to di m light has favoured the flights.

Results of studies regarding effect of humidity on marriage flights of ants have been somewhat conflicting. Kannowski and Kannowski (1957), as well as Kannowski (1959a) were of the opinion that relative humidity does not effect the flights of ants in any way. Way (1954) and Talbot (1963) have shown that high relative humidity is favourable for flights. Kannowski (1959b) has recorded a relative humidity 80 to 99 percent favourable for the flights of **Dolichoderous** sp., Gupta (1970) found low relative humidity favourable for the flight of **M. setipes** and high relative humidity favourable for **C. compressus.** Under the investigations in hand, the range of relative humidity favourable for the flights of the two species of **Holocomyrmex** was recorded as 66 to 98 percent. All these reports lead us to the conclusion that perhaps relative humidity favourable for flights of ants is different with different species.

The flights of both the species of **Holocomyrmex** took place in the evening after rains in the morning. This confirms the conclusion of Weber (1952), Way (1954), Coarsey et al (1958), Collingwood (1958), Kannowski (1959), Talbot (1963) and Gupta (1970) that rains either precede or follow the flight because the wet soil favours digging and colony foundation which soon follow the flights. However, Brian and Brian (1955) in the studies on **Myrmica rubra** Later., Talbot (1964) on **Formica obscuriventris** Mayr., and Gupta (1970) on **M. setipes** reached a contradictory conclusion.

Flights of ants under the present studies took place in calm to slight wind conditions. Earlier authors Chapman (1954, 1957), Brian and Brian (1955), Talbot (1956, 1959, 1963, 1964, 1966), Kannowski and Kannowski (1957) and Kannowski (1959 a and 1959 b) have also shown that strong winds are not favourable for flights. The reason appears to be that strong wind might carry heavy helpless females very far to an altogether different type of environment which may not be suitable for the species.

Intraspecific differences between the two species of **Holocomyrmex are** also note worthy in that the flight seasons and the ranges of humidity for the flights of these species of the same genus have been different as shown in the data reproduced in this paper. Flight season ranged from 30-6-69 to 18-7-69 in **H. scabriceps** and 11-7-69 to 30-7-69 in **H. criniceps.**

Table 1

Dates and durations of five flights of H. criniceps

Date	Duration of flight.	
	From	To
11.7.69	7:16 P. M.	7:38 P. M.
18.7.69	Not recorded	7:45 P. M.
26.7.69	Not recorded	7:40 P. M.
27.7.69	7:20 P. M.	7:40 P. M.
30.7.69	7:15 P. M.	7:42 P. M.

Table 2

Climatological range under which flights occurred in two species.

Species.	Time	Average temp. of the day °C	Rel. humidity %	Light intensity.	Sky conditions.	Wind.
H. criniceps	7 : 15 P.M. to 7 : 45 P.M.	24.8 to 31	87 to 98	Poor To dim	cloudy	calm to slight.
H.scabriceps	7 : 15 P.M. to 7 : 45 P.M.	26.5 to 30.1	66 to 93	Poor to dim	clear to cloudy	calm to slight.

Table 3

Flight of H. criniceps on 11.7.69

Sexes.	Time of emergence from nest hole.	Time of being air borne	Time of the end of flight.	Flight duration Minutes	Approximate no. of individuals air-borne in flight duration.	Approximate no. of alates taking flight from the nest per minute.	Size of flight.
Male	7 : 16 P.M.	7 : 25 P.M.	7 : 34 P.M.	9	200	18 to 24	Moderate
Female	7 : 18 P.M.	7 : 27 P.M.	7 : 38 P.M.	11	54	4 to 7	Moderate

Table 4

Dates and duration of three flights of H. scabriceps.

Dates.	Durations of flights.	
	From	To
30.6.69	7 : 15 P. M.	7 : 35 P. M.
11.7.69	Not recorded	7 : 45 P. M.
18.7.69	7 : 20 P.M.	7 : 35 P. M.

SUMMARY

The paper records the results of studies carried out on the marriage flights of the two species of the ant genus **Holocomyrmex** i. e. **H. criniceps** and **H. scabriceps** in the campus of Gurukula Kangri Vishwavidyalaya, Hardwar, Uttar Pradesh, India, during 1969. A brief description of the locality has been given. Definitions and sources of ecological data used in the paper have been mentioned. Both the species have been dealt with separately. After giving a brief introduction of each species, its marriage flights have been described in detail with special reference

to the weather conditions. Observations have been recorded on such aspects of the flight as: activity of the workers before the emergence of the alates, emergence of the alates, alates taking positions for the flights etc. Then follows a discussion with works of earlier authors on the flights of other species of ants. The conclusions arrived at, are as follows:—

(i) High temperature of the air is favourable for flights.
The usual range is between 15° C to 38° C.

(ii) Humidity and intensity of light favourable for flights vary with different species.

(iii) Rains usually either precede or follow the flights because the wet soil favours digging and colony foundation which takes place soon after the flights. But there are also some contradictions of this conclusion.

(iv) Strong winds are not favourable for flights.

(v) Intraspecific differences in the flights are noteworthy.

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ON THE COLLECTION OF FISHES OF THE SONG RIVER IN DUN VALLY UTTAR PRADESH

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INTRODUCTION

The fish fauna of the Doon Valley has attracted several workers on account of its interesting distribution. The most notable contributions had been those of Hora and Mukerjee (1976) who reported upon 21 species collected from the various streams. Subsequently Das (1960), Lal and Chatterjee (1942) and Singh (1964) added a further list of 26 species brining to a total of 47 species recorded from the Doon Valley. The present communication gives an account of fishes inhabiting the eastern part of the valley.

Material and Methods

The fish specimens were collected by using minnow sciene in the entire width of the stream. In the weed-infested areas and in rapids dip net was also operated. In addition, fish material collected from Doon valley during the past seven years in the D. A. V. (Post-Graduate) College was also examined. The identification of fish species is based on Day (1878), Misra (1959) and Srivastava (1968).

Fish Fauna

The fish species recorded from the Song area are listed in table I alongwith the localities in Doon Valley and their distribution elsewhere in the sub-continent.

TABLE 1

S.No.	Species	Local Distribution+	General Distribution.
	FAMILY CYPRINIDAE		
1.	*Schizothorax progastus* (Mc Clelland)	3,5.	Himalayas to Upper Assam.
2.	*Tor tor* (Hamilton)	2,3,4,5.	Mountain streams of India, Pakistan and Ceylon.
3.	*Tor putitora* (Hamilton)	2,3,4,5.	Mountain streams of India, Pakistan and Ceylon.
4.	*Puntius sarana* (Hamilton)	2,3,5.	Fresh waters of India, Pakistan & Ceylon.
5.	*Puntius stigma* (Hamilton)	2,4,5.	Freshwaters of India, Pakistan & Burma, Also found in brackish waters of the above-said places.
6.	*Puntius sophore* (Hamilton)	2,3,4,5	Fresh & brackish waters of India, Pakishtan and Burma.
7.	*Puntius ticto* (Hamilton)	1,2,3,4,5.	India, Pakistan & Ceylon.
8.	*Puntius chagunio* (Hamilton)	2,3,5.	Northern India & Pakistan.

9.	*Puntius chillinoides* (Mc Clelland)	3,5.	Eastern Himalayas and Ganges.
10.	*Puntius chola* (Hamilton)	2,3,5.	Widely distributed in fresh waters of India, Pakistan and Burma.
11.	*Barilius barna* (Hamilton)	2,5.	Assam, Ganges, Bengal & Orissa.
12.	*Barilius bendelisis* (Hamilton)	1,2,3,4,5.	Assam, Himalayas, through the continent India except Malabar Canara and Sindh. Found also in Ceylon.
13.	*Barilius vagra* (Hamilton)	2,5.	Sindh hills, Himalayas and Sub Himalayan range, Jumna and Ganges, also in Punjab, Assam & Ceylon.
14.	*Oxygaster bacaila* (Hamilton)	2,3,5.	Freshwaters of India and Pakistan.
15.	*Crossocheilus* (Hamilton)	2,5.	Fresh waters of Northern part of India.
16.	*Danio devario* (Hamilton)	2,3,4,5.	Fresh waters of Northern India & Pakistan.
17.	*Danio (Brachydanio) rerio* (Hamilton)	1,3,5.	Bengal and as low down the Coromandel.
18.	*Garra gotyla* (Gray)	2,3,4,5.	From Syria throughout India and Ceylon. Found also at Abyssinia and Aden.
19.	*Labeo calbasu* (Hamilton)	2,3,4,5	India, Pakistan & Burma.
20.	*Laben dero* (Hamilton)	2,3,4,5.	Along the Himalayas in India, Burma & Ceylon.
21.	*Labeo dyocheilus* (Hamilton)	3,4,5.	Sindh hills and Himalayas, Sikkim & Assam.
22.	*Labeo pangusia* (Himilton)	2,3,5.	Himalayas, Sindh, Deccan and N. W. Provinces, Bengal, Cachar and Assam.
23.	*Raimas bola* (Hamilton)	2,3,4,5.	Orrisa, Bengal, N. W. Provinces, Assam & Burma.
24.	*Rasbora daniconius* (Hamilton)	2,3,5.	India, Pakistan, Burma & Malaya Archipelago.
	FAMILY COBITIDAE		
25.	*Botia geto* (Hamilton)	1,2,3,5.	From Sind through the Punjab, Himalayas, valley of the Ganges, Jumna & Sone rivers of Assam.
26.	*Lepidocephalichthys guntea* (Hamilton)	1,3,5.	Northern India & Pakistan.
27.	*Noemacheilus botia* (Hamilton)	1,3,4,	Sind, Punjab India and Ceylon.
28.	*Noemacheilus rupecola* (Mc Clelland)	2,4,5.	Himalayas and Tibet.
29.	*Noemacheilus savona* (Hamilton)	2,5.	Bengal and N. W. Provinces.
	FAMILY HETEROPNEUSTIDAE		
31.	*Amblyceps mangois* (Hamilton)	1,3.	The Himalayas; found in Jumna, also through Burma to Moulmein.

	FAMILY SISORDIAE		
32.	*Glgptothorax pectinopterus* (MeClelland)	3,5.	Himalayas throughout Punjab, Simla, Kangra and Darjeeling.
33.	*Wallogo attu* (Bleeker & Schn)	3.	Freshwaters of India, Pakistan, Ceylon, Burma to Java, Sumatra, Siam and Indochina.
	FAMILY OPHIOCEPHALIDAE		
34.	*Channa gachua* (Hamilton)	1,2,3,5.	Freshwaters throughout India, Ceylon, Burma and the Andamans. Found also near Gwadar.
35.	*Channa punctatus* (Bloch)	1,2,3,5.	Freshwaters frequently in the plains of India.
36.	*Channa striatus* (Bloch)	1,2,3,5.	Freshwaters, throughout the plains of India, Ceylon, Burma.
	FAMILY MASTOCEMBELIDAE		
37.	*Mastocembelus armatus armatus* (Lacepede)	2,3,5	Balcuhistan, Pakistan, India, Ceylon, Nepal, Burma,
	FAMILY NANDIDAE		
38.	*Badis badis* (Hamilton)	2,3.	Freshwaters of India, Pakistan & Burma.
	FAMILY BELONDIDAE		
39.	*Xenentodon cancila* (Hamilton)	2,3,4,5.	Freshwaters of India, Burma, Pakistan and Ceylon.
	FAMILY BAGRIDAE		
40.	*Mystus* (*Mystus*) *cavasius* (Hamilton)	3,5.	Northern part of India, Pakistan & Burma
41.	*Mystus* (*Mystus*) *gulio* (Hamilton)	2,3,5.	Seas, estuaries and tidal waters from Sind and Bombay, throughout India & Burma to the Malay Archipelago.
42.	*Mystus* (*Osteobagrus*) *seenghala* (Sykes)	2,3,4,5.	Yunan, India, Pakistan & Burma.
43.	*Mystus* (*Mystus*) *teengra* (Hamilton)	2,3,4,5.	Northern part of India, Pakistan and Madhya Pradesh.
44.	*Mystus* (*Mystus*) *vittatus* (Bloch)	2,3,4,5.	India, Pakistan, Ceylon, Burma and Siam.

Conclusions

Hora and Mukerjee in 1936 described twentyone fishes; later on 14 fishes were added by Lal and Chatterjee in 1942, out of which I doubt the existence of *Esomus daniricus* (Hamilton) and *Puntius phutunio* (Hamilton) in eastern Doon waters as no one were caught in the duration of collection trips. However, *Badis badis* (Hamilton) and *Labeo dyocheilus* (Hamilton) were also collected and the statement of Singh (1964) while contradicting Lal and Chatterjee (1942) that these two fishes were not found during the course of his investigations proves to be false. Twelve

* The numerals given in this column refer to the locality numbers corresponding to those described in the Appendix A.

more unrecorded fishes have been claimed by singh (1964), out of which I am doubtful about the existance of *Oreinus plagiostomus* (Hecke), *Amblypharyngodon mola* (Hamilton) and *Noemacheilus scaturigina* (McClelland). *Wallago attu* (Bleeker & Schn) is a new record from this area. On the basis of the data collected it is concluded that 44 species of fish only were collected in the Song River.

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Description of the Localities Surveyed

Locality No. 1. Song river at Goolar Ghati; depth 50 cm; bottom covered with dark brown algal growth; lies between 30°14′ least latitude and 78°8′ north latitude.

Locality No. 2. Song river at Lachiwala; depth 30 cm to 90 cm, which during rains ranges between 1 m to 5 m; lies between 30°11′ 30″ east latitude and 78°8′ 3″ north latitude.

Locality No. 3. Song river at Dowiwala; depth of 15 cm to 60 cm and ranges from 90 cm to 2.5 m during rains; bottom covered with algae; lies between 30°10′ 30″ east latitude and 78 17′ north latitude.

Locality No. 4. Song river at Kansro; depth 30 to 90 cm, which during rains ranges from 1.5 m to 2.5 m; bottom covered with green and brown alage; lies between 30°5″ 30″ east latitude and 78°4′ north latitude.

Locality No. 5. Song river at Railwala; depth 30 cm to 90 cm which during rains ranges between 30°2′ east longitude and 78°12′ 30″ north latitude.

MORPHOLOGY AND HISTOLOGY OF THE BRAIN OF TOR TOR (HAMILTON) IN RELATION TO ITS FEEDING HABITS.

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Communicated by : Dr. M. B. Lal

Introduction

Morphology of the brain of fishes has been worked out by several workers in India and abroad but little work has been done on the aspect of histology of the fish brain. The present paper deals with the morphology and histology of the brain of Tor tor in relation to its feeding habits.

Tor tor is a typical hill stream cyprinoid fish popularly called mahseer. It is an omnivorous fish which is found to feed on algal filaments, gastropods, insects, sand, gravels etc.

Historical resume

Wright (1885) was the first biologist who studied the nervous system and sense organs of *Ameiurus*. Later many scientists undertook this aspect of research work from time to time. Evans in his series of publications (1931, 32, 35, 37, 40, and 52) gave an illustrated account of the morphology of the brain of British cyprinoids, Clupeoids in relation to the feeding habits. Kurepina and Pavlovsky (1946) and Pavlovsky (1953) gave an extensive account of fish brain in various families in relation to habitation. In India, Bhimachar (1935, 37 45/1, 45/2) worked on the structural variations in the hind brain of Cyprinoids and Cyprinodonts of South India. He also studied the acoustic centres of the air breathing fishes of India. Mukerjee and Ganguly (1948) worked on the topography of brain and also on the gross histology of medullar region of teleostean fishes in relation to feeding habits. Khanna and Singh (1966) and Saxena (1967) gave an account of the morphology of the teleostean brain in relation to the feeding habits.

Nieuwenhuys (1959, 60, 62, 63) made a valuable contribution on the structure of actinopterygion forebrain in his series of publications.

Meterial and methods

Tor tor is widely distributed in almost all the hill streams of Himalayan region and is found in abundance in the rivers of Doon valley. The living specimens were collected from the river Song and Suswa of the adjacent parts of Dehra Dun. The cranium of the fish was opened from the sides and roof and brain was taken out carefully and preserved in various fixatives. For the morphological study the brain taken out was preserved in 5% Formol while for the histology, Bouin's fluid, Muller's fluid, Zenker's fixative, Alcohol-acetic acid etc. were used. The slides were prepared by the usual procedure.

Observations

Morphology—The brain of *Tor tor* is small in proportion to the size of the fish. It is 40.000mm long in a fish of 260.0mm. length. The brain lies enclosed in cranial cavity protected by three fibroelastic coverings alongwith fatty globules. The brain can be differentiated into

the forebrain, the midbrain and the hindbrain. The forebrain comprises of olfactory sacs, olfactory bulbs, olfactory tracts, cerebral hemispheres and diencephalon region.

The olfactory bulbs (fig. 1 o1.b.) are a pair of small bodies which lie much ahead of the rest of the brain. Each bulb is oval-shaped and is applied closely to the cup-shaped olfactory sac of its own side. Posteriorly the olfactory bulb is continued as an elongated olfactory tract (ol. t.) which is counected with the anteroventral end of the cerebral hemisphere of its own side.

The *cerebral hemispheres* (fig. 1, cer. hem.) are somewhat elongated paired structures of, considerable size. The roof or pallium is thin, and on its ventral side a ganglionic mass, the corpora striata is situated.

The *diencephalon* region lies inbetween the cerebral hemispheres and optic lobes. Dorsally it is indicated by a small pineal body (fig. 1 p. b.) which lies hidden beneath the membranous roof of the brain. The anterior choroid plexus, a thin network of blood capillaries is situated on the dorsal surface of the diencephalon. On ventral side the diencephalon comprises of an infundibulum, hypophysis, saccus vasculosus and lobi inferiores.

The *Infundibulum* is a funnel-shaped inward prolongation which lies in the floor and is partially covered by the optic tract which lies on its ventral side. Hypophysis is a flattened structure partially covered by the optic tract which lie on its whtral side Hypophysis is a flattened structure which is carried out by a stalk and remains within the brain membrane at the floor of the cranium. The accous vasculosus (fig. 1,b;s.v.) is some what oval in Sape and is located on the posterior side of the infundibulum. On its lateral sides lie paired bean-shaped lobi inferiores (10.inf.)

The right and left halves of the forebrain are connected by three transverse bands of fibres called as anterior, posterior and inferior commissures which are situated in the region of corpora striata, behind the origin of pineal body and in front of infundibulum respectively.

The midbrain or *Mesencephalon* consists of a pair of well developed large, oval optic lobes (fig. 1, a; op. 1.). Both the optic lobes lie quite apart at the postero-median line as is seen in the dorsal view of the brain (fig. 1, a.). On the ventral side the optic lobes remain partly covered by the infundibular outgrowths of the diencephalon region. From the anterolateral side of each optic lobe arises an optic tract (*op. t.*) which runs obliquely forward and is fused with its fellow at their bases.

The hindbrain consists of a *cerebellum* and the *medulla oblongata.* The *cerebellum* (fig. 1, cbl.) is well developed elongated portion of the brain situated on the anterior side of the medulla oblongata and partially covers the latter. Anteriorly the cerebellum is pushed under the roof of the midbrain to form valvula cerebelli while posteriorly it narrows down slightly and is bent upon itself.

The *medulla oblongata* (fig. 1, m. o.) is the hindmost subdivision of the brain. It is broad in front and narrows down posteriorly where it continues as the spinal cord outside the foramen magnum. Medulla oblongata is partly covered by the cerebellum on its dorsal side. The posteri-

or choriod plexus, a thin network of blood capillaries is also located on the roof of the medulla oblongata.

The *facial* and *vagal* lobes are situated on the dorsal and lateral sides of the medulla oblongata respectively. They lie hidden beneath the cerebellum. The facial lobe (fig. 1, f. l.) is a conspicuous median structure which is somewhat rounded and lies inbetween the two vagal lobes. The paired vagal lobes (fig. 1. v.l.) are oval structures located on either side of the facial lobe. The 7th or facial and 10th or vagus cranial nerves arise from the facial and vagal lobes respectively.

Histology

A transverse section through the olfactory bulb (fig. 2, a) shows that it comprises of a number of layers arranged concentrically. The ventricle of the olfactory bulb is so vestigeal that the bulb looks almost solid. The various layers, although not very well differentiable, can be recogonised as follows——

1. Superficial layer (supl.) is thin and single-celled.
2. A white or medullary layer having large number of small cells is the external cell layer (ex. c.l.).
3. A layer of large nerve cells with smaller ones intermingled is termed as internal cell layer (int. c. l.).
4. The layer of olfactory nerve fibres (o. n. f.) is located inbetween the above two cell layers. The nuclei of the nerve cells also increase in size towards the centre and they take deep blue stain of haemotoxylin. The rest of the portion takes pink stain of eosin. The central most area of the olfactory bulb is termed as olfactory nucleus (o. n.) by Sheldon (1912). A well marked olfactory ventricle is not observed in *Tor tor*.

The olfactory tract is an outgrowth from the cerebral hemisphere and joins the olfactory bulb of its own side. Its cavity becomes obliterated inthe development. The neuroglia occupies the central portion which is surrounded by white or medullary substance consisting of bundles of longitudinal nerve fibres continuous with the fibres of the olfactory bulb. The outermost layer is thin and single celled.

In a transverse section through the *cerebral hemispheres* (fig 2, b, c) the grey matter forms the cerebral cortex It consists of a number of pyramidal cells which vary in thickness and size at various levels and depth. The layers of pyramidal cells are named according to their size and depth The outermost layer, the plexiform layer (p.l.), is only one cell thick and made up of columnar cells. The various pyramidal cell layers are, however, not sharply differentiable and vary in their rlative development. The layer lying just below the plexiform layer is known as the layer of small pyramidal cells (l.s.p.) The cells of this layer are small and closely packed The nuclei are small and take deep blue stain of haemotoxylin. This layer is four to five cells deep on the dorsal and lateral sides while it is less developed on the ventral side. Layer of small pyramids is followed by the layer of medium-sized pyramids (l.m.p.) The cells are slightly

bigger than those of the layer of small pyramids and nuclei are also somewhat bigger and not conjested. They also take a deep blue stain of haemotoxylin. This layer is more developed on the inner lateral sides where it achieves a thickness of 10 to 15 cells deep. It is also prominent on the dorsal side. The thickness of the pyramidal layers gradually increases towards the centre The layer of medium sized pyramids is followed by the layer of superficial and large pyramids (l.s.l.p.) The cells are much bigger than those of previous layers and the nuclei lie much far apart and are bigger They also take blue stain of haemotoxylin. This layer is much better developed on the lateral sides where it acquires a thickness of 8 to 10 or more cells. In the central zone the pyramids are largest in size and consequently the nuclei are also biggest. These constitute the layer of the deep large pyramids (l.d.l.p.) and occupy the middle half of the whole cerebral cortex. The white matter is distributed in the form of fibrous streaks in between the various layers of pyramids. The blood capillaries are also noticeable in the form ofa few oval and round small spaces present in the cortex. The ventral half portion of the cerebral hemisphere at the level of corpora striata is occupied by a thick mass of nerve fibres which take a pink stain of eosin. The two corpora striata are joined by an anterior commissure made up of the closely packed fibres.

The two cerebral hemispheres are separated by median slit-like ventricle (Nieuwenhuys 1959) covered by a thin membranous roof which is the stretched wall of telencephalon. This generally gets disrupted in the preparation of slides.

The ventricle is lined by ciliated epithelium, a ependymal layer (ep. l.), which helps in the movement of cerebro-spinal fluid contained in the ventricle.

In a transverse section through *diencephalon* region (fig.2,d), on the dorsal side there are seen two ganglia of habenulae made up of small cells in the region of pineal body while on the ventral side the infundibulum is a downward prolongation ventral to which is situated the pituitory body. It is vascular in nature, consisting of two layers--the outer layer stains pink and inner blue. The inner layer is composed of neurosecretory cells and is granular. The pituitory body is carried by a stalk which is composed of a bundle of nerve fibres. The saccus vasculosus (fig. 2d, s.v.) is a median sac which is made up of small closely set nerve cells, the outer layer of which stains pink with eosin while the inner one differentiated by layer of grey matter, made up of nerve cells provided with granules. It gets stained blue with haemotoxylin. The nuclei are dark and prominent. The saccus vasculosus contains a small cavity (c. s. v.) which is the prolongation of diocoele. On the lateral sides of saccus vasculosus the paired lobi inferiores (lo. inf.) are observed. Each inferior lobe is bean-shaped and contains a small cavity (c. lo. inf.) which is the p olongation of the diocoele. The cavity is lined by a layer of grey matter, which takes a blue stain and its nuclei are deep and prominent. The rest of the grey matter of lobi inferior is somewhat like that of a cortex made up of nerve cells. The outermost layer is one cell-thick. The nuclei of the suceeding layer are bigger on the lateral sides where it assumes much more thickness. The nuclei of the subsequent layers are slightly smaller but this layer attains more thickness. The nuclei of the inner and central area are comparatively bigger. All the

nuclei take blue stain of haemotoxylin while rest of the structure is stained pink with eosin. There is a well marked congregation of grey matter in the form of oval bundles on the inner lateral sides of lobi inferiores. The nuclei show congregation of nerve cells. The white matter is distributed on the sides and also in the grey matter. Under these bundles there are further seen two more comparatively small oblong bundles with conjested nuclei. Under this there is a layer of transverse bands of fibres which is the demarcation of the territory of the diencephalon from of the mesencephalon.

that of the mesencephalon.

A transverre section through mesencephalon (figl 2, i.) shows a dorsal optic tectum and the ventral tegmentum. Tectum consists of corpora bigemina. The tectum and tegmentum are separated by an optic ventricle or optocoele (o. v.). A small but conspicuous cavity, the aqueduct of sylvius, is observed. It is lined by an epithelium and is drawn out laterally and a little ventrally. It is surrounded by the grey matter. On its dorsal side there are two small oval bundles but on the lateral sides there are two large bundles. These are the centres for the origin of the 3rd or oculomotor (n. o. n.) and 4th or trochlear (n. t. n.) cranial nerves. The white matter is distributed in the form of transverse bands of fibres and fibrous streaks. The reticular formation of mesencephalon is known as *tegmentum* (teg.) It is surrounded by *crusta* (crs.) on the sides. Crusta presents a congregation of longitudinal and transverse fibres intermingled with much grey matter. Inbetween the two bundles of fibres there is a reticular structure, the tract of *fillet* (t.f.). The fillet is broader at its both ends. The inner ventrolateral border of the cursta is made up of a layer of grey matter which presents an agregation of nerve cells. It is *substantia nigra* (sub. n.). The nuclei are stained dark blue. The two optic lobes or corpora bigemina are joined to each other in the middorsal line by *tori longitudinalis* (t. l.). They are two some what bean-shaped masses of nerve cells, the nuclei of which are stained deep blue. The valvula cerebelli (v.c.) shows two areas—one molecular area (m.v.c.) and another granular area (g.v.c.). Area molecularis takes pink stain with eosin while the area granulosum presents a congregation of nuclei which stain blue with the haemotoxylin. In a T. S. through *cerebellum* (fig. 2, f.) it consists of an outer cortex of grey matter and an inner core of white matter. In the middle there is a strip of white matter called as white area (w. a.) which is surrounded by grey matter on all sides. The grey matter immediately surrounding the white matter has a granular appearance which takes a blue siain. Its shape is like a hollow broad cup with a small invagination in the centre. It consists of a number of closely set nerve cells. The nuclei are stained dark blue. This is granular area or area granulosum (g. a.). It is surrounded by the area molecularis (m. a.) on all sides and is made up of chiefly the nerve fibres or axons of the nerve cells constituting the granular area which took a characteristic pink stain of eosin. The molecular area is better developed on the dors l surface. Few nerve cells are also scattered inbetween. Them olecular and granular areas are separated by some large flask-shaped cells which can be compared to the cells of purkinje of higher vertebrates.

On the ventral side of the cerebellum there is an acoustic area (a. a.). Its cells are stained blue with haemotoxylin, and are intermingled with the cells of the molecular layer at the ventral boundary. The nuclei of these cells take deep blue stain with haemotoxylin.

In a transverse section through the *medulla oblongata* (fig. 2, g) a small cavity, the 4th ventricle (v.), is observed. On its latero-ventral side a reticular structure, the area reticularis (r). r.), is seen. Here most of the grey matter becomes broken off by the passage of bundles of nerve fibres. On the lower side of the ventricle there are two bundles of fibres. These are *fasciculus longitudinalis medialis* (f. l. m.). On its lateral sides there are two more large bundles the great *longitudinal gustatory tracts* (g. l. g. t.). On either side of the medulla there is a prominent mass of white fibres which is termed as pyramid(py.), and the left and right halves of the pyramids are joined in the midventral line by a narrow raphe (r.) made up of longitudinal and oblique fibres. In a transverse section there are situated a median facial (f. l.) and lateral vagal lobes (v. l.) on the dorsal boundry of the medulla oblongata. The nuclei of these are in the form of oval or round bundles of fibres which appear as protuberances on the medulla. Nuclei (n. n.) for the 5th, 6th and 9th cranial nerves are also observed as oval and round bundles at different levels of medulla.

Discussion

The brain of *Tor tor* does not appear to depart basically from the typical teleostean plan. However few differences are noteworthy. In *Tor tor* the olfactory lobes are absent and the olfactory bulbs lie much advance of the rest of the brain and are borne on the long slender olfactory tracts arising from the anteroventral ends of the cerebral himispheres. While in some teleosts the olfactory tracts may be short or entirely absent. The olfactory bulbs may be replaced by the olfactory lobes e. g. *Mastocembelus armatus*. In very few cases both the bulbs and lobes are observed e. g. *Puntius ticto*, *Noemachelus rupicol* by Khanna and Singh (1966).

The cerebral hemispheres, diencephalon, midbrain present more or less the same structure as in other fishes. They are very well developed in *Tor tor*. In the hindbrain the cerebellum is well developed in general but facial and vagal lobes of the medulla oblongata are differently developed in different fishes. One or the other may or may not be preent ors both may be well developed or indistinct. They are well developed in *Tor tor*. Due to better development of these lobes the cerebellum appears slightly elevated at its posterior end. Evans (1935) observed that thefacial and vagal lobes are peculiarly developed in Cyprinoids in relation to the feeding habits, and emphasis is laid that the structure of the forebrain cannot be orrelated with the feeding habits of fish.

Evans (1931) classified the British Cyprinoids into three chief groupsas follows—

1. *Mouth tasters*—It includes those fishes which detect their food from the mud with the help of the barbels. In these fishes the vagal and facial lobes of medulla oblongata are prominent.

2. *Sight feeders*—It comprises of those fishes which find their food in the upper level of the water with the help of vision. The facial and vagal lobes of medulla are comparatively smaller and the barbels are conspicuously absent.

fig. I

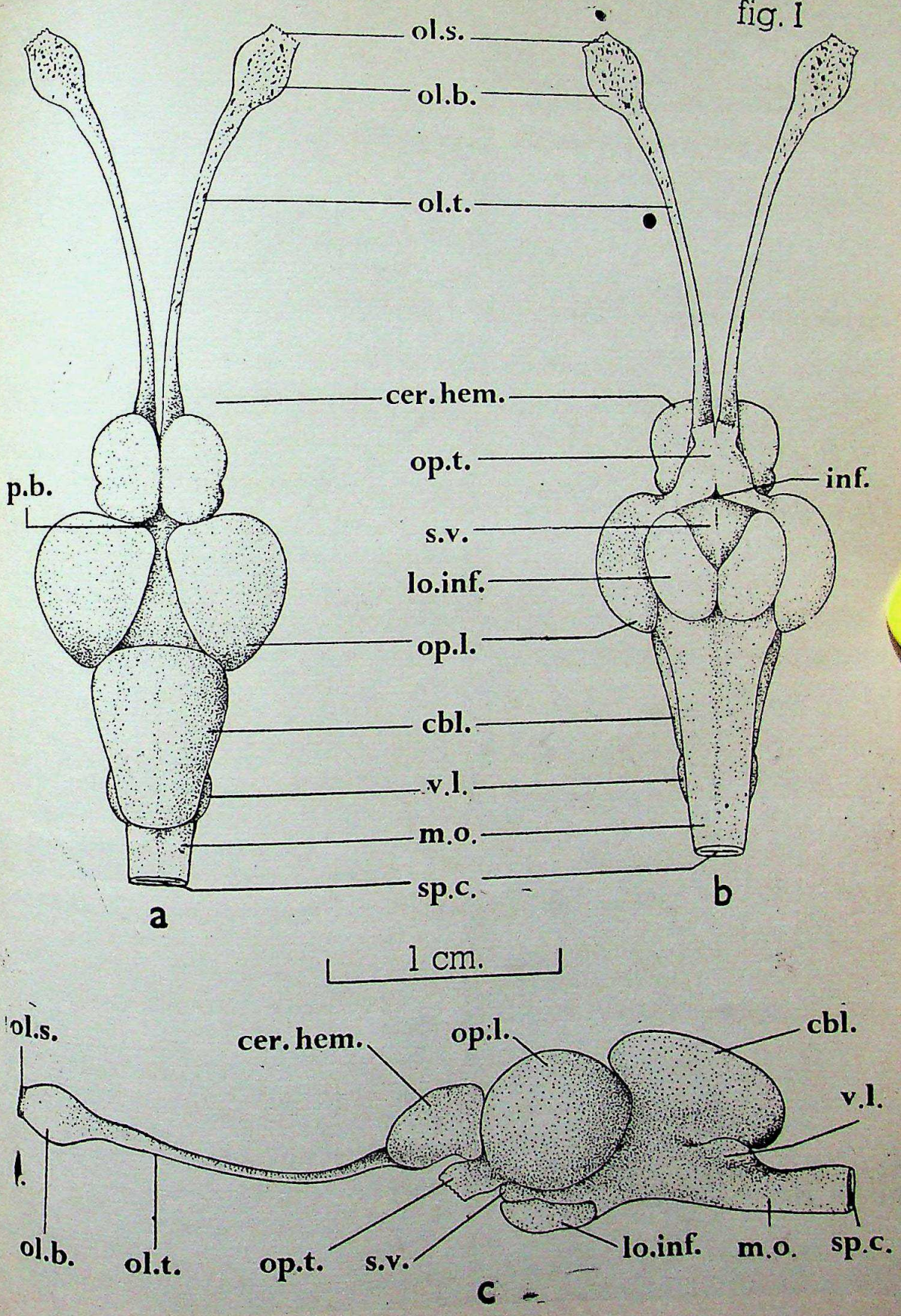
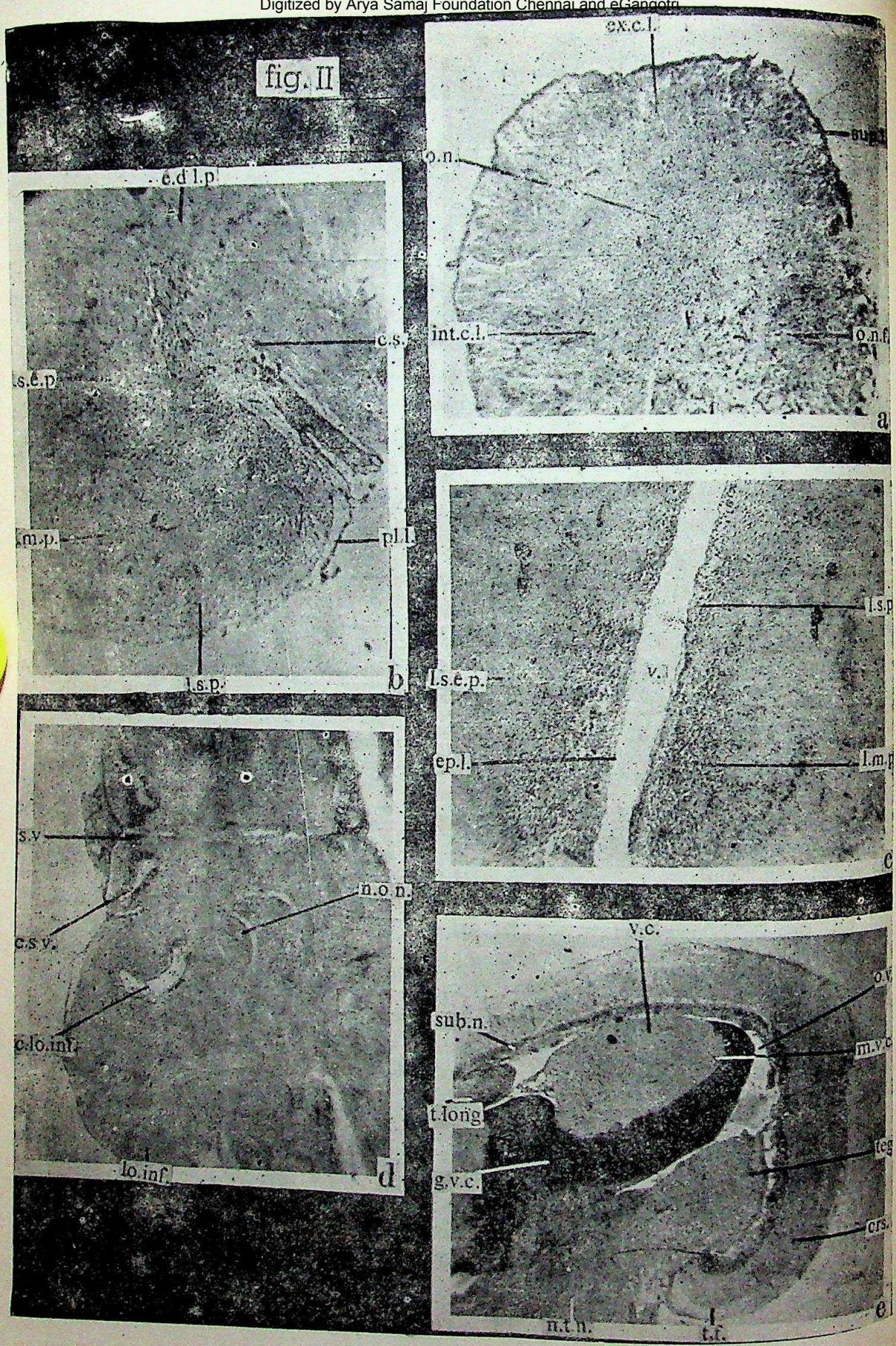
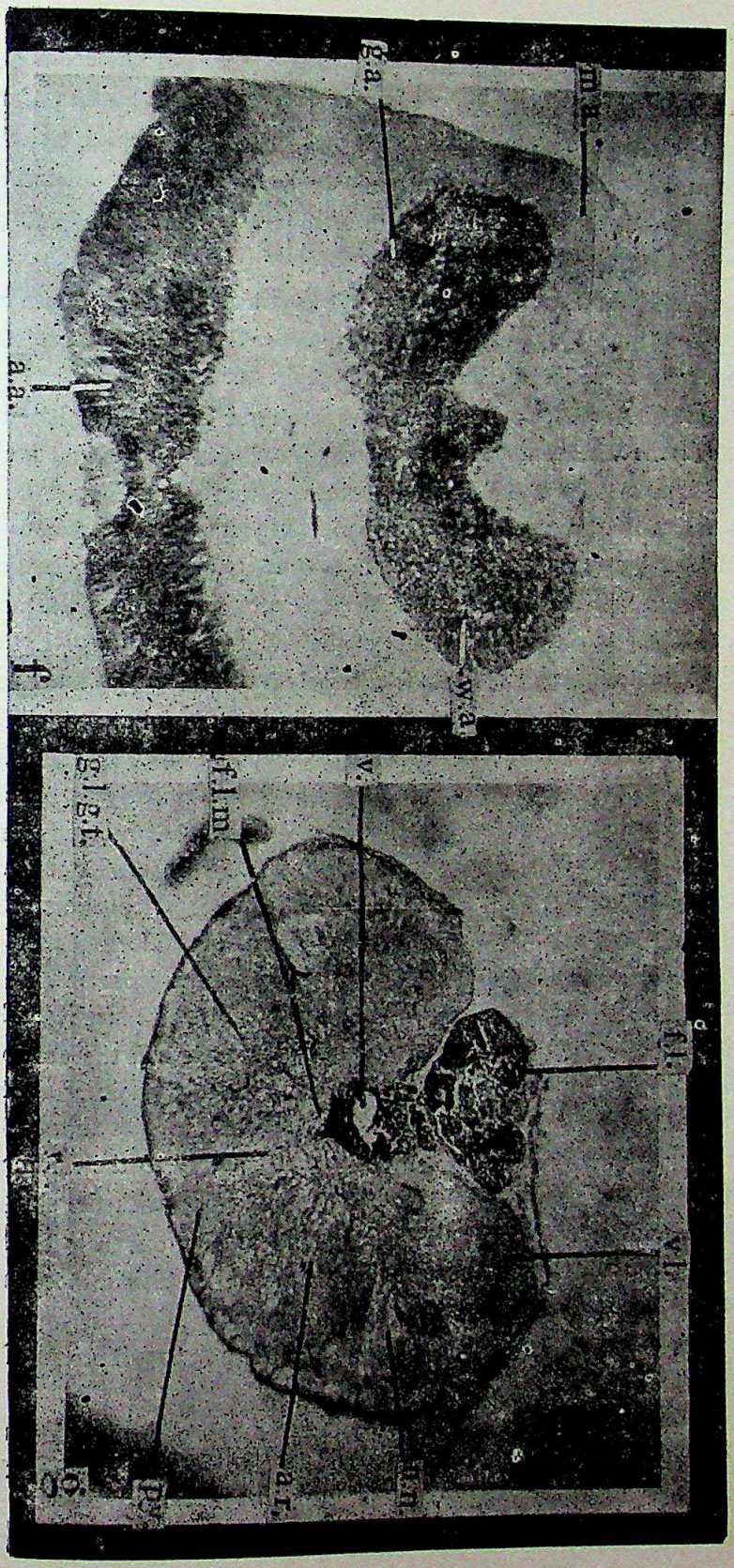


fig. II





3. *Skin tasters*—The vagal and facial lobes are small and barbels are also comparatively smaller. The skin of the snout region and body is provided with numerous sense organs which help the fish in searching out the food material from the mud at the bottom of the river.

Later on, Bhimachar (1935) classified South Indian Cyprinoids & Cyprinodonts into two main groups comprising of taste-feeders and sight-feeders. He further subdivided the first group into two subgroups—(a) feeding with the help of mouth taste and (b) sorting out of the food material with the help of barbels.

Mookerjee, Ganguly and Mookerjee (1950) classified their fishes into three groups—(1) includes those fishes that feed largely by taste (2) includes those fishes which feed largely by taste and sight (3) includes those fishes that feed largely by sight.

Khanna and Singh (1966) divided the fishes into three groups—(1) fishes that feed by sight and mouth taste (2) the fishes that feed with the help of barbels (3) fishes that feed by taste. They stressed that the sense of smell also plays an important part in searching out the food in the fishes of third group, where olfactory lobes are developed and the olfactory nerves are stout and strong. In the first and second groups only small olfactory bulbs are present (*Puntius ticto* and *Noemachelus rupicola*, however, are the exceptions which possess olfactory lobes also).

Saxena (1967) grouped the fishes under the following headings—1. Bottom dwellers—these are subdivided into three groups—(a) feed largely by olfactory, gustatory or lateral senses—Here the olfactory lobes, acoustic tubercles are prominent. Facial and vagal lobes are reduced. (b) Feed largely by olfactory sense and taste—Here the olfactory lobes, acoustic area, facial and vagal lobes are prominent. (c) Feed largely by sense of taste (mostly by barbels)—Facial lobe, olfactory bulbs, acoustic area are prominent but the vagal lobes are reduced.

2. Mid-and surface-Water dwellers—Feed largely by sense of sight and taste — vagal lobes,optic lobes are prominent while the facial lobe is reduced. Acoustic area is present.

3. Surface dwellers—Feed mainly by sight—Here the optic lobes and acoustic area are prominent. Facial, vagal and the olfactory lobes are indistinctly present.

The fishes which belong to the group of mouth tasters possess large vagal lobes and facial lobe is also prominent While these parts are poorly developed in the group of sight feeders. Bhimachar (1935) observed that the fishes which feed by taste may either make use of the taste buds present over the mouth and lips or on the barbels. It implies that the mouth tasters of Bhimachar have less prominent barbels. This is contradictory to the finding of Evans (1952) who observed that the mouth tasters of Bhimachar correspond with the skin tasters of Evans.

The well developed optic lobes help the fishes in searching out their food by visual perception. As all the teleostean fishes directly or indirectly depend on vision, therefore, the optic lobes are more or less well developed in all the fishes.

The development of cerebellum is said to be related to the equilibrium of the fish in water. So the cerebellum is also well developed.

The central acoustic area is concerned with the mode of hearing or with the constant exposure into the external atmosphere (Bhimachar 1945). Bhimachar observed that the acoustic

area is well developed in the airbreathing fishes which come to the surface of the water to gulp air.

Tor tor possesses well developed facial and vagal lobes. Besides these, there are four barbels which point out towards the fact that it is a taste feeder feeding with the help of barbels. On the basis of above classifications it comes under the group 1 of Evans (1931; 52) i. e. Mouth tasters, group 1/b of Bhimachar (1935) and group 2 of Khanna and Singh (1966) i. e. Taste feeders sorting out food with the help of barbels. The optic lobes are well developed in *Tor tor* and it shows that the vision also plays an important role in searching out the food material. On the basis of this, *Tor tor* can be included in the group 2 of Mookerjee, Ganguly and Mookerjee (1950) comprising of those fishes which feed by taste and sight, and group 2 of Saxena (1967) comprising of mid and surface water dwellers feeding with the help of sight and mouth taste.

The presence of acoustic area shows that the fish comes to upper surface from midwater to collect its food and, therefore, is exposed to the external atmospheric sounds. Moreover, the hill streams are only few feet deep and there is not much marked difference in the bottom and surface levels and so the fishes are directly or indirectly exposed to the sunlight and sound. They also depend on vision in the selection of food.

SUMMARY

1. The morphology and histology of the brain of *Tor tor* are worked out and it is found that the structure of brain more or less resembles that of a typical teleostean brain.
2. The structural modifications of the brain are correlated with the feeding habits of the fish.
3. Fishes in relation to the feeding habits can be grouped-under three headings—
   (1) Fishes that feed with the help of vision.
   (2) Fishes that feed with the help of mouth taste.
   (3) Fishes that feed with the help of the barbels for the assortment of food material.

On the basis of this classification *Tor tor* comes under the third group i. e. taste feeders which take the help of the barbels. It also relies on the visual perception for searching out its food. Therefore, it falls in group 1 mouth tasters of Evans (31, 52) and group 1/b of of Bhimachar (1935, 37), group 2 of taste & sight feeders of *Mookerjee and others* (1950) Khanna and Singh (1966) and group 1/b of Saxena (1967). This group is characterized by the presence of barbels & well developed optic lobes. *Tor tor* possesses four barbels. The olfactory lobes are absent. It shows that the sense of smell does not play any part in the procurement of food.

Acknowledgement—

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Explanation for Figure 2

(a) T. S. through olfactory bulb —

ex. c. l. — external cell layer

int. c. l. — internal cell layer

o. n. — olfactory nucleus

o. n. f. — olfactory nerve fibres

sup. l. — superficial layer

(b) T. S. through cerebral hemisphere showing ventral part—

c. s. — corpora striata

l. d. l. p. — layer of deep large pyramids

l. m. p. — layer of medium sized pyramids

l. s. l. p. — layer of superficial large pyramids

l. s. p. — layer of small pyramids
pl. l. — plexiform layer

(c) T. S. through cerebral hemispheres showing median ventricle—
ep. l. — ependymal layer
l. m. p. — layer of medium sized pyramids
l. s. l. p. — layer of superficial large pyramids
l. s. p. — layer of small pyramids
v. — ventricle

(d) T. S. through diencephalon—
c. lo. inf. — cavity of lobi inferior
c.s. v. — cavity of saccus vasculosus
lo. inf. — lobi inferior
n. o. n. — nucleus of oculomotor nerve
s. v. — saccus vasculosus

(e) T. S. through midbrain—
crs. — crusta
g. v. c. — granular area of valvula cerebelli
m. v. c. — molecular area of valvula cerebelli
n. t. n. — nucleus of trochlear nerve
o. v. — optic ventricle
sub. n. — substantia nigra
teg. — tegmentum
t. l. — torus longitudinalis
t. f. — tract of fillet
v. c. — valvula cerebelli

(f) T. S. through cerebellum—
a. a. — acoustic area
g. a. — granular area
w. a. — white area

(g) T. S. through medulla oblongata—
a. r. — area reticularis
f. l. — facial lobe
f. l. m. — fasciculus longitudinalis medialis
f. v. — fourth ventricle
g. l. g. t. — great longitudinal gustatory tract
n .n. — nuclecti for 5th, 6th cranial nerves
py. — pyramid
r. — raphe
v. l. — vagal lobe

Explanation for figure I

Brain of *Tor tor*

a – Dorsal view
b – Ventral view
c – Lateral view

ABBREVIATIONS

cbl. – cerebellum
cer. hem — cerebral hemisphere
inf. — infundibulvm
lo. inf. — lobi inferior
m. o. — medulla oblongata
ol. b. — olfactory bulb
ol. s. — olfactory sac
ol. t. — olfactory tract
ol. l. — optic lobe
op. t. — optic tract
p. b. — pineal body
s. v. — saccus vaculosus
sp. c. — spinal cord
v. l. — vagal lobe.

ECOLOGICAL STUDIES ON THE ANT *MYRMECOCYSTUS SETIPES* FOREL*

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INTRODUCTION

Myrmecocystus setipes Forel is a large-sized ant with workers, males and queens having body lengths approximately of 10-12 mm., 11-13 mm. and 13-14 mm. respectively, It is confined to the drier parts of western Uttar Pradesh, Madhya Pradesh, Punjab and Rajasthan. Its distribution, however, extends westwards into Persia through Pakistan and Afghanistan, and it is, closely related to the North Africans species *Myrmecocystus viaticus* Forel. It is one of the very common ants in the area of its distribution, and constructs subterranean nests in exposed situations. Inspite of the fact that this ant is of wide occurrence in arid zone of the country, very little is known about its life and habits. Rothney (1889) has pointed out its habits of constructing its nests in the hard-baked earth in most exposed situations. Also his observations record that the workers have a strong propensity of marching in regular lines of about 12 to 20 members at great speed. He believed that the ant did not practise slavery. Bingham (1903) refers only to a taxonomic description of the workers. Hingston (1123) is the only other worker who has contributed a passing remark on the habits of this ant. The present paper deals with some aspects of the life of this ant which are important from ecological point of view. It also impresses upon some important and interesting features of comparison between two other species of ants *Oecophylla smaragdina* Fabr. and *Camponotus compressus* Fabr. which are common and abundant in the locality under study.

Studies were carried out in the campus of Gurukul Kangri Vishwavidyalaya, Hardwar, U. P. during the years 1962 and 1963. A description of the locality, geographical situation and climatic conditions of Hardwar has been given earlier (Gupta 1968a).

Observations have been recoded mostly from a four mife stretch of unmetalled canal road (Fig. 1) on the north side of Gurukul Kangri Vishwavidyalaya from Mayapur bridge to Jatwara bridge along the Upper Ganges Canal. On the south of the road is a belt of *Tectona grandis* Linn., *Shorea robusta* Goerin, *Terminalia arjuna* Bedd., and of xerophytic *Carissa carandas* Linn., as well as *Zyziphus* sp. The undergrowth is that of *Adhatoda vasica* Nees and *Lantana indica* Roxb. There is a mango grove at level with the Jatwara bridge. The northern side of the road is sunny and bare with about two feet high raised up bank of the canal.

FORAGING ACTIVITIES

On their foraging activities, workers of *M. setipes* Forel collect seeds of grass and *Lantana*, dried petals of flowers, pieces of begasse, rice grains, sugar crystals and starch, dragon flies, crickets,

* A part of the thesis approved by the Agra University for the degree of Ph. D. in 1964.

earwigs, *Dysdercus* bugs, moths, lady-bird beetles, other small beetles, *C.compressus* ants, honey bees, *Polistes* wasps, and millipedes. Insects belonging to Carabidae, Elateridae, Curculionidae, Tenebrionidae and Coccinellidae (Coleoptera), Coreidae (Heteroptera) and Jassidae (Homoptera) and other Formicidae have been found living, dead or mutilated in the excavated soil of the nests.

NESTS AND NESTING HABITS

The nests of *M. setipes* Forel usually occur on bare ground devoid of vegetation. If the nests are afterwards overgrown with grass, herbs and other vegetation, they are abandoned and new nests are excavated in the nearest bare patch. Exposed pnd south-facing situations (Fig.1) are preferred which provide ideal conditions for insolation. During hot months occasionally nests are also found on flat ground and north-facing slopes. Interference by man or trampling by cattle often forces the ants to abandon their normal nests and construct new ones on ground which otherwise may not be preferred.

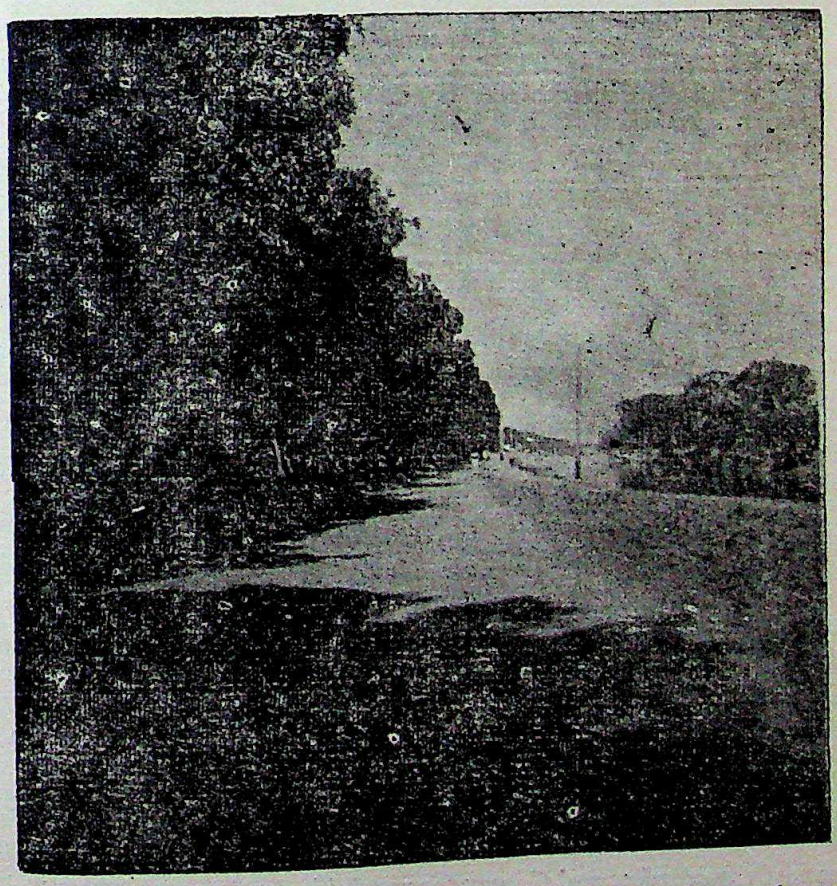

Fig. 1 The Canal Road. On the right hand side the canal embankment shows the southfacing slope which is the most favoured place for construction of nests by *M. setipes*.

The nest of *M. setipes* Forel is typically a crater nest (Figs. 2 and 3), that is, the earth and materials brought to the surface and rejected during excavations are piled up around the nest entrance in the form of a crater. The entrance normally lies on a south-facing slope at a height of about a foot from the ground. The vertical situations are not at all preferred for nest construction, perhaps due to the difficulty encountered in climbing a vertical plane. Like *O. smaragdina* Fabr., *M. setipes* cannot conveniently climb up a smooth vertical surface. This ant has never been observed travelling up and down a tree trunk as do *O. smaragdina* Fabr. and *C. compressus* Fabr.

Fig. 2 A nest of *M. setipes* on southfacing slope. Arrow at top middle portion of the figure shows the crescentic nest hole. Note the excavated soil accumulation below the nest hole and also towards the right as well as left side of it.

Experimentally when tried, *M. setipes* though succeeded in climbing a short distance with difficulty on a rough veritcal surface, yet could not gain height of even two inches on glass surface. On the other hand *O. smaragdina* and *C. compressus* exhibited no discomforture in climbing such smooth surfaces. On the horizontal surface, however, *M. setipes* moves much faster than both the *O. smaragdina* and *C. compressus* Fabr., as is apparent from Table 1.

TABLE 1 *Statement showing the speeds of* O. smaragdina M. setipes *and* C. compressus.

Name	Caste	Speed per second
O. smaragdina	Worker	5.0 cms.
M. setipes	Worker	13.5 cms.
C. compressus	Worker	8.0 cms.
C. compressus	Soldier	7.5 cms.

The nest entrance of a well-formed nest has a characteristic cresentic shape (Fig 2) with the longitudinal axis always oriented east-west The well-plastered upper margin of the entrance is produced into an arched projection over the slit-like entrance perhaps to act as a sort of sun-breaker. From this projection a sharply pointed mud process is produced downward which partly divides the entrance into two. This normal shape of the nest entrances may be spoiled by the age of the nest, by crumbling and cracking, by rain or by other biotic and abiotic agencies. Nests on the flat ground (Fig. 3) have nearly the same shape of entrance though the directions of the different projections may be somewhat altered. The excavated soil accumulates outside

Fig. 3 A nest of *M. setipes* on flat or horizontal ground surface to show the typical crater formation. Arrow shows the nest hole with excavated soil accumulation outside.

the nest hole in the form of a crater. On the south-facing slopes the expanse of the excavated earth in the form of pellets which afterwards crumble into a coarse sandy soil, begins from the nest hole and extends up to the ground level, finally assuming an east-west longitudinal axis below the nest hole. This results in the surrounding of the nest by this soil from the east, the west, and the south down to the level of the ground. Only a very small amount of the excavated soil accumulates on the upper or northern side of the nest hole. On flat ground the accumulation of the excavated soil, though follows the same characteristic pattern, yet the side of the heavy accumulation may vary from nest to nest (not always the southern side as in the case of the nests on the south-facing slope), resulting in the formation of craters. In the case of *C. compressus*, however, the excavated soil around the nest hole of a well-formed nest is deposited uniformly on all sides of the circular nest hole. The approximate dimensions of the well-formed nest of *M. setipes* Forel on the south-facing slope (Fig. 2) are :—

1.	Length of the crescentic opening	2.0 — 0.5 cms.
2.	Maximum width	0.8 — 2.0 cms.
3.	Length of the slope	60.0 — 80.0 cms.
4.	East-west axis of the excavated soil	60.0 — 70.0 cms.
5.	Vertical depth of the excavated soil	10.0 — 18.0 cms.

A well-formed nest on the flat ground (Fig. 3) was found to have the following approximate dimensions :—

1.	Length on the nest hole	6.5 cms.
2.	Width of the nest hole	3.5 cms.
3.	Maximum length of the excavated soil in the north-east direction	45.0 — 50 cms.
4.	Minimum length of the excavated soil on the south-west direction	20.0 cms.
5.	Maximum depth of the excavated soil	15.0 cms.

A nest of moderate size situated on flat ground when dug up led into a somewhat oblique gallery up to about 30 cms. depth at the end of which workers in large numbers were found aggregating. On further digging down this spot the passage led into still deeper oblique galleries. One such gallery ended at a distance of about 60 cms. from the surface of the ground and at the end of which the brood was kept sheltered. The nest hole of another nest led into a vertical gallery downwards, and at a depth of about 15 cms. was found a cluster of larvae and pupae guarded by a number of workers. After a depth of about 30 cms. this gallery led to oblique galleries in different directions, and workers were found upto a depth of about 75 cms. after which the galleries ended blindly.

Under laboratory conditions when *M. setipes* workers were kept in a cake jar full of moderately moist soil, they excavated oblique galleries of about 1.0 cm. dimeater in a zigzag fashion running mostly on the south-eastern side of the jar which was exposed to sunshine.

The disposal of the excavated soil pellets by the ants reveals a sharp intelligence on the part of the workers. The pellet is released from the mandibles at the highest point of the crater in such a way that it rolls down on the outside of the crater and never has a chance of rerolling into the entrance of the gallery.

A reference to Fig. 5 indicates that roughly there are two cycles of nest-building activites during the year. The first cycle begins in the begining of the spring season (February) and

continues up to the end of April when there is a decline which is further accentuated by rains. After the rainy season ceases there is a sudden spurt in the nest-building activity. Maximum nests were found during October and November.

EFFECT OF TEMPERATURE

The importance of temperature as an ecological factor with special reference to the life of ants has been well impressed by Gupta (1956). Observations have been recorded in the case of *M. setipes* and they show that temperature has a noteworthy influence on its activity and its choice of nesting sites.

Activity

Activity constitutes the act of nest-building, excavating, defending the colony, cleaning the nest and foraging etc. The number of *M. setipes* Forel workers active at any one time is limited. Under the optimum conditions of activity no more than about two dozen ants can be seen excavating the soil at the nest and some would be found foraging in the hot sun to long distances. The workers engaged in the excavating duties move in groups like the formations of an army. They generally march in a formation of two rows of six workers each. The whole squad (approximately 12 in number) moves together into the nest, gathers minute bits of earth in the mandibles and turns about to deposit their load outside the nest. Activity unit of *M. setipes* in the present considerations has therefore been expressed in terms of the actual number of ants excavating or otherwise found active within one metre diameter around the nest hole at any given time. It will be useful here to point out that activity at all the nests even under the same conditions of temperature does not exhibit a uniform pattern. From the data given in table 2 it is apparent that *M. setipes* Forel is a very hardy ant and can tolerate comfortably as high a temperature as

TABLE 2. *Temprature—activity relations of* M. setipes

Observation No.	Temperature°C.	Activity
1	12	0
2	13	2
3	14	3
4	16	8
5	17	12
6	18	12
7	21	12
8	22	25
9	25	25
10	30	25
11	35	25
12	40	25
13	45	25
14	50	25
15	55	25

55°C. at which its activity does not show any decline. It is reasonably safe to assume rhat *M. setipes* Forel may find even still higher temperatures quite favourable. On the lower scale its activity completely ceases at 13°C. below which it just lives without showing any activity. With a gradual rise of temperature to about 22°C. there is a proportional rise in the activity. The maximum is recorded from 22°C. to beyond 55°C. It is quite indicative that the optimum temperature for activity of *M. setipes* covers an extremely wide range, that is, from 22°C. to 55°C. At Hardwar the temperature in the shade never goes beyond 45°C. during the whole year and consequently *M. setipes* is never immobilised by high temperature and can be seen quite commonly even during the hottest months. A study of the table 3 reveals that dry and hot months of March, April, May and June, when the shade temperature may be as high as 45°C. and open sunny ground temperature 55°C., are most favourable for activity. The minimum activity is recorded during the cold months of December and January when the average maximum temperature never rises beyond 21°C. with a minimum average temperature of 5°C.

TABLE 3. *Average activity of* M. setipes *expressed in average number of ants active, at different hours during different months.*

Month	Number of ants active at different times					Average
	6 a. m.	12 a.m.	6 p. m.	8 p. m.	10 p. m.	
January	0	6	0	0	0	1.2
February	0	10	8	6	0	4.8
March	3	12	10	10	5	8.0
April	5	10	8	5	6	6.8
May	8	14	8	8	6	8.8
June	6	18	7	2	0	6.6
July	3	8	2	0	0	2.6
August	2	10	9	0	0	4.2
September	0	6	2	0	0	1.6
October	0	12	9	1	0	4.2
November	0	10	0	0	0	2.0
December	0	6	0	0	0	1.2
Average	2.3	10.0	5.3	2.7	1.5	

Daily average activity also shows that maximum activity is attained at midday when temperature is highest, while both in the morning and evening with low temperatures there is a proportionate decline in the activity (table 3). At low temperatures the activity is confined to the act of excavations at the nest while it is only at very high temperatures and specially in the sun that the ants go for foraging.

Choice of nesting sites

As mentioned above, most of the nests of *M. setipes* are situated on south facing slopes where optimal temperature conditions are available during the greater part of the day. Growth

of grass and other vegetation near or around the nest also reduces the effect of favourable insolation by obstructing the sun's rays and preventing them from reaching the nest hole. The vegetation also lowers the temperature on account of its general cooling effect. The result is that nests are usually found on exposed grounds devoid of vegetation. Further when a nest is overgrown with grass, it is abandoned. The effect of the availability of exposed situations to some extent results in a greater abundance of nests during the month of February, March, October and November, which are months of scanty vegetation. Nests on flat ground or on north-facing slopes have also been occasionally seen from May to August, when due to high temperatures insolation is perhaps not an acute problem. It is interesting to note that the response shown by *M. setipes* in the choice of its nesting sites in relation to temperature and insolation is almost identical to that of *O. smaragdina* (Gupta 1966).

M. setipes almost always prefers higher temperature wherever it is available. During low temperature conditions the nest temperature 10.0 cms. below the surface is invariably found to be relatively higher than the temperature prevailing outside the nest. The low unfavourable outside temperature coupled with comparatively high temperature within the nest makes the ants retire to their colonies causing a pronounced fall in their activity. On the contrary during hot months when the temperature is relatively higher outside the nest than inside, the ants move out of their colonies in greater number for various activities. This shows that the ants take the fullest advantage of the favourable temperature conditions provided by the variations in temperature between the nest temperature and the external temperature. It is significant to record that the temperature of the nest throughout the year does not show a very wide range of variation. It fluctuates within a rather relatively narrow range of 14°C. to 75°C. as compared to the wide range of optimum temperature for the ants' activity which lies between 22°C. and more than 55°C. The fluctuations in temperature immediately below the surface of the soil are fairly wide and well-marked, but in the deeper layers of the soil the fluctuations are generally obliterated, and an almost constant temperature with a very narrow variation is maintained (Sinclair 1922).

EFFECT OF LIGHT

No one has uptil now recorded anything about the light as an environmental factor and its bearing on the life of *M. setipes*. A perusal of table 3 shows that the activity of the ant is at its peak at midday hours and in months from March to June which are periods of great intensities of light. The ant therefore prefers strong light for its activity. As the light decreases, activity goes down. A comparison of table 3 with data reproduced earlier (Gupta 1968b) on *O. smaragdina.* reveals some interesting facts. In the case of *O. smaragdina.* the peak conditions of activity extend over five months, that is, from April to August while in the case of *M. setipes* they are recorded only for four months, that is, from March to June. Though *O. smaragdina* continues to show greater activity during July and August which are months of lesser intensities of light due to clouds and rains, the activity of *M. setipes* is much reduced. *M. setipes* therefore, it seems, prefers greater light intensities than *O. smaragdina.*Similarly daily activity of *M. setipes*

Forel also demonstrates a preference for the sunny hours of the day (table 3). In the early and late hours of the day the activity is almost brought to a stand still as compared to peak activity during the midday period of intense sunshine.

EFFECT OF WIND

Wind has been found to have a very important influence on the life of certain ants like *O. smargdina* Fabr. (Gupta 1968) and *C. compressus* Fabr. (Gupta 1963). Observations on *M. setipes* Forel under the present investigations have however shown that the wind has no appreciable effect on the activities of this ant.

EFFECT OF HUMIDITY

The effect of temperature and humidity on the activity of *M. setipes* Forel as shown in fig. 4 reveals that this ant is more sensitive to humidity than *O. smaragdina* Fabr. (Gupta 1968).

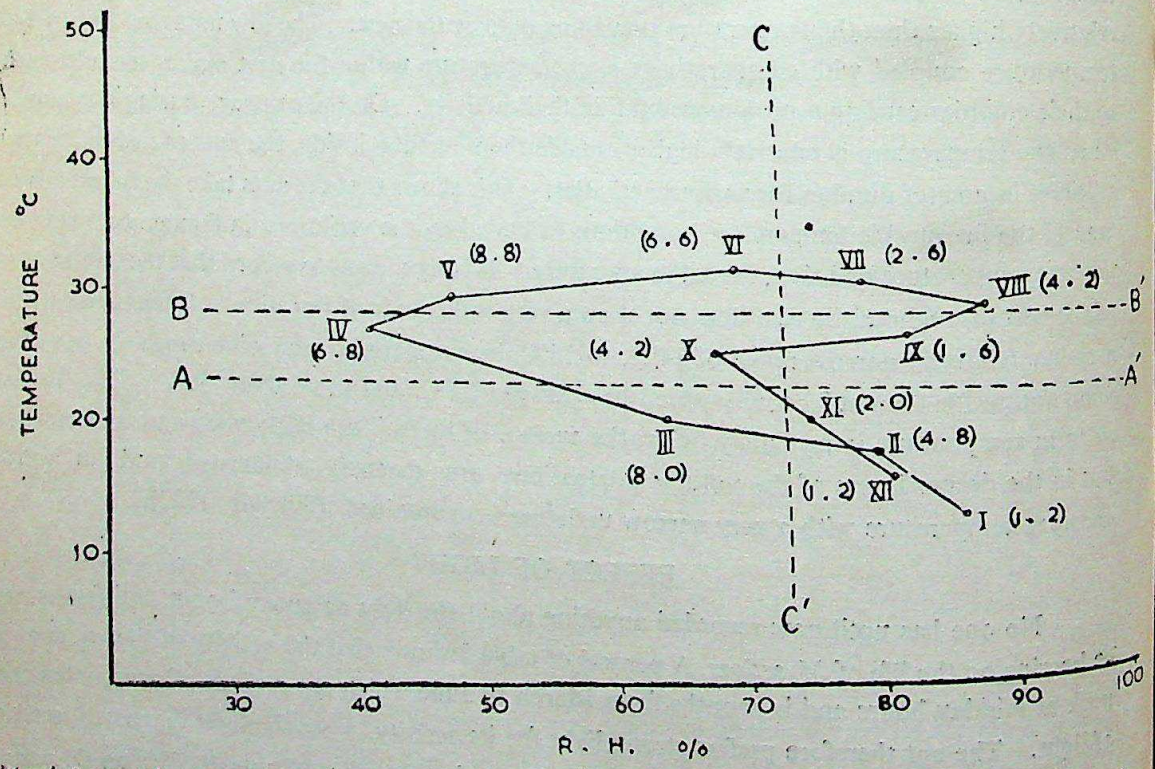

Fig. 4 A complex graph showing the influence of humidity and temperature on the activity of *M. setipes* during different months. Roman numerals I to XII represent months from January to December, and figures within brackets indicate average activity. Lines AA' and BB' fail to divide the graph into zones of low activity, mild activity and brisk activity as found in the case of *O. smaragdina* (Gupta 1968b.) The vertical line CC', however, separates the high activity zone (low humidity zone) to the left from the low activity zone (high humidity zone) towards the right, thereby demonstrating that in the case of *M. setipes*, relative humidity has greater influence than temperature.

For the sake of simplicity and clarity the average monthly activity of *M. setipes* Forel as shown in column 7 of table 3 and noted in brackets in fig. 4, is divided into three grades—

1.	Low	1.2 — 2.6
2.	Moderate	4.2 — 4.8
3.	High	6.6 — 8.8

The three regions of the graph in fig. 4 divided and marked by the two horizontal lines AA'and BB'show all the three grades of activity lying in each one of them, thereby indicating that the activity can be high, moderate or low within a wide range of temperature. If the graph is divided by a vertical line CC' the two regions of the graph, that is, right and left represent a marked contrast. Relative humidity between 45% and 75% is most favourable for activity while a r in relative humidity beyond 75% almost immediately brings a fall in activity. This preference for drier conditions is further emphasised by the distribution of the species which is normally confined to the sandy and arid zones. The picture presented by the graph as a whole also demonstrates that the influence of humidity is relatively more pronounced than that of temperature. This is in sharp contrast with the influence on *O. smaragdina* (Gupta 1968b) where temperature is more important than humidity. The requirements of greater intensities of light for *M. setipes* also show its preferneces for low humidity and drier conditions, because the solar radiations have an adverse effect on humidity. During foraging activities *M. septipes* collects seeds and stores them in the nest. This seed-collecting habit is a clear indication of an aridity-loving temperament (Wheeler 1926).

EFFECT OF RAIN

Rain as an ecological factor has a much more pronounced effect on *M. setipes* Forel than that which has been realised in the case of *O. smaragdina* Fabr. earlier (Gupta 1968). A reference to table 4 would reveal that maximum activity is attained during the arid months of March,April, May and June and with the onset of rain the activity shows a marked decline in the month of July. Low relative humidity is not the sole factor which determines activity. Its effects are to some extent modified by temperature. Low humidity with high temperature as in drier months, is an extremely favourable condition. High temperature, however, (with high humidity) has adverse efiect. Similarly the favourable effect of low humidity is offset by the low temperature prevaliling in winter months of December and January and the activity falls down.

TABLE 4. *Activity of* M. setipes *at different conditions of rainfall.*

Month	Average rainfall in inches	Average activity
January	2.6	1.2
February	0.6	4.8
March	0.9	8.0
April	0.0	6.8
May	0.4	8.8
June	2.9	6.6
July	10.8	2.6
August	10.4	4.2
September	9.9	1.6
October	0.0	4.2
November	0.3	2.0
December	0.7	1.2

It is interesting to note that whereas *M. setipes* Forel shows its maximum activity during hot drier months, *O. smaragdina* Fabr. is most active during hot and humid months of July and August (Gupta 1968). Rains in winter have a uniform effect of reducing the activity of both of these ants due to the modifying influence of low temperatures. In the case of *M. setipes* Forel even mild showers quickly drive the ants into their nests, which emerge again after the stoppage of rain o resume their excavating activity with renewed vigour, perhaps to reconstruct the craters damaged by rains. Similar views have been expressed by Wilson (1959) and Scherba (1961). The watering of the land around the nests of *M. setipes* Forel has also the same effec of reducing the activity.

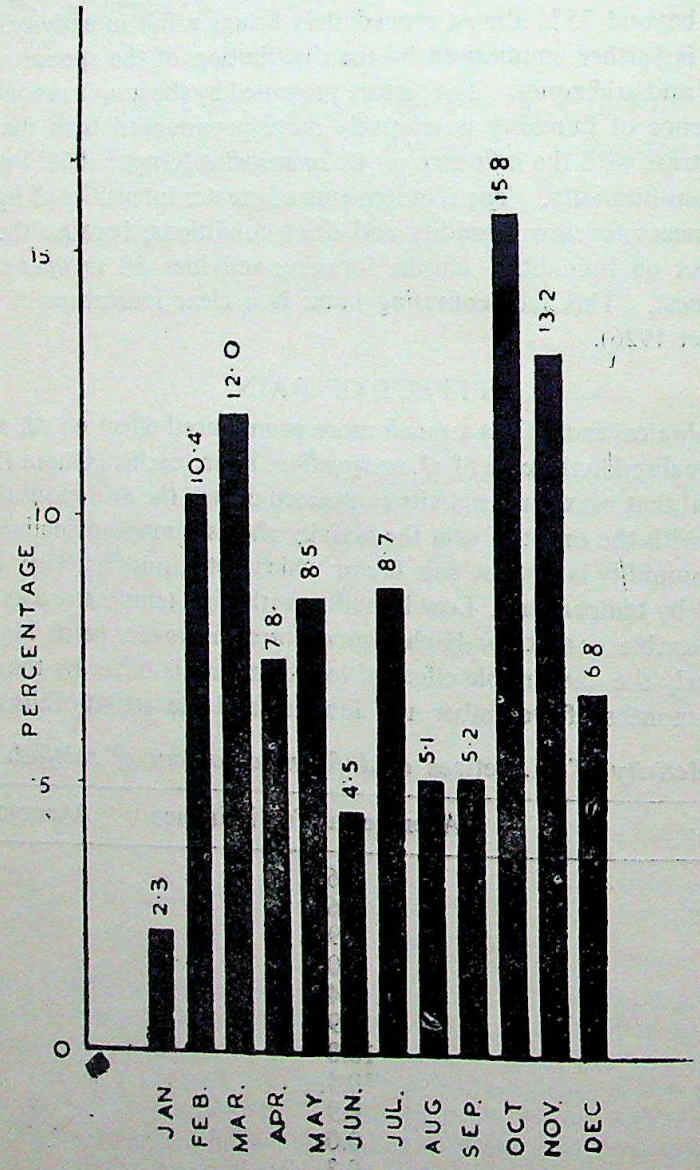

Fig 5 Histogram sdowing the percentage of *M. Setipes* nests observed in different months out of the total number of nests observed in a year.

The number of nests occurring in an area is greatly affected by the rains. As is evidenced by fig.5, the percentages of nests during drier nonths, like February, March, October and November, are much higher than in rainy months of July, August and September. A careful study of fig. 6 will show that a mere low rainfall unaccompanied by relatively higher temperature is not a favourable factor for nest-building activity.

The preference for drier conditions, seems to be at the back of the selection of slopes for nests which provide protection against flooding by rain. Similarly the formation of craters is undoubtedly an adaptation against floods. Coarsey et al (1958) also considered the adaptive value of mounds and the craters against the periodic flooding.

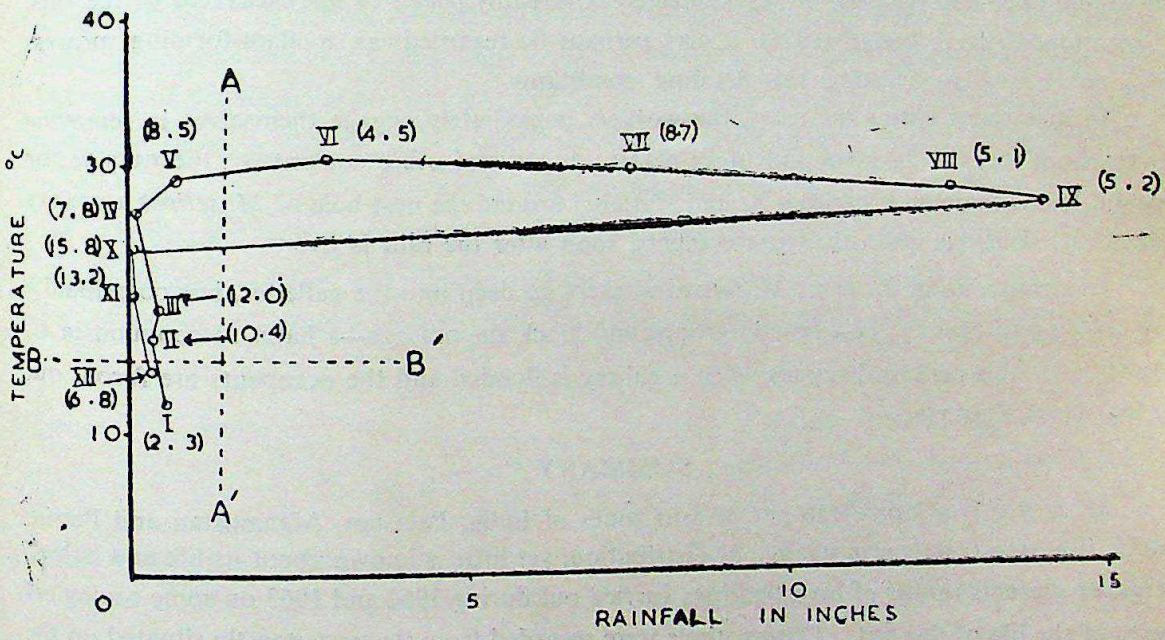

Fig. 6. A complex graph showing the influence of temperature and rainfall on the incidence of *M. setipes* nests in different months. The roman numerals I to XII represent months from January to December and figures within brackets indicate the percentage of nests out of the total number of nests observed during the year.

Lines AA' and BB' divide the graph into four zones. Months with high temprature and low rainfail (upper left zone) show greater incidence of nests while the months with high temperature and heavy rainfall (upper right zone) exhibit low incidence of nests. The lowest incidence is fund during months of low temperature and low rainfall (left lower zone).

For a fuller appreciation of the effects of rains on *M. setipes* Forel it is worthwhile to mention some special behaviour patterns of the ant towards the water stimulus. This ant exhibits a marked avoidance reaction to water. Under laboratory conditions when the water is provided in a tilted petri dish, the ants always remain on the drier raised-up part of the dish and reach the water very carefully for drinking, as the cattle do from the side of a pond. Like *O. smaragdina*

when sealed in tubes full of water (Gupta 1968b), *M. setipes* dies within half a minute or so. When experimentally liberated in a glass trough half full of water, the *M. setipes* Forel workers vigorously swim out towards the rim of the trough to escape, but due to their inability to climb a vertical polished glass surface they fail to do so. As soon as a small stick touching the edge of the glass surface is provided the worker uses it as a bridge to climb out of the water. If by some chance the workers happen to fall on the backs in a puddle of water, they swim for some time on their backs, then bring themselves in normal position and make for the nearest place where dry ground may be available.

Water provided for the workers of *M. setipes* in petri dishes in artificial nests has very often been found filled and the petri dishes completely covered by pellets of soil excavated by the ants. As mentioned by Wheeler (1926) it may perhaps be regarded as a dam-forming process and a novel way of meeting the flooding conditions.

In case water enters the nests, the workers immediately engage themselves in removing heir stores of seeds of *Lantana* and other plants, pupae and other contents to the outside for drying. It is a common experience to find scattered around the nest hole of *M. setipes* a variety of seeds, dead insects and other nest contents, soon after the rain is over.

Generally during the rains *M. setipes* workers go deep into the galleries, but occasionally they come up to near the nest hole in groups and block the passage—a habit so common in *C. compressus*. This perhaps happens when a gallery is flooded and the occupants are forced out to seek other drier places.

SUMMARY

M. setipes is a large-sized ant of arid zones of India, Pakistan, Afghanistan and Persia. Though it is very common in its area of distribution, yet little is known about its life and habits. The paper presents results of investigations carried out during 1962 and 1963 on some ecological aspects of the life of this ant. Observations were recorded from the nests mostly situated on the canal road by the side of the Gurukula Kangri Vishwavidyalaya Hardwar U. P. India. Reference has also been made to the important points of comparison between this ant and the other two species of ants, that is, *O. smaragdina* and *C. compressus*, which are also very common in and around the locality under study.

On its foraging activities the ant has been seen to collect seeds of *Lantana* and of grasses, dried petals of flowers, pieces of begasse, rice grains, sugar crystals, starch and quite a good variety of insects.

M. setipes is a subterranean ant and constructs nests in exposed situations. Nests have usually been found to occur on bare ground devoid of vegetation. In case the nests are afterwards overgrown with grass, herbs or other vegetation, they are abondoned and new nests are excavated. Nesting site is usually selected on a sloping and sunny ground. The soil excavated during nest construction is accumulated unequally around the opening of the nest to form a sort of crater. The entrance to the nest is characteristically crescentic with the longitudinal axis orient-

taed in the east-west direction. From one side of the crescentic opening a small pointed mud projection is formed which perhaps partly divides the entrance into two portions to regulate the trafic. There are roughly two cycles of nest-building activities during the year.

M. setipes is fond of higher temperatures and drier conditions. It can comfortably tolerate as high a temperature as 55°C. Its lower threshold temperature for activity outside the nest lies at 13°C. The range of optimum temperature is extermely wide and lies between 22°C. and 55°C. Its cold tolerance is not rather as pronounced as that of *O. smaragdina*. Sunshine has a pronounced influence over the activity of this ant. In the early and late hours of the day, the activity is almost brought to a stand-still while midday exhibits the maximum activity. Wind does not seem to have any effect on this ant *M. setipes* is more sensitive to humidity than *O. smaragdina* Fabr. Rains have marked adverse effect on the activity of *M. setipes* The incidence of nests in an area declines during rainy season. Preference for drier conditions seems to be at the back of the selection of slopy grounds for nestbuilding which provides protection against flooding by rains. Under laboratory conditions *M. setipes* shows an avoiding reaction to water.

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THE EFFECT OF BROMIDE AND IODIDE CATIONS ON THE RATE OF DISSOLUTION OF A LOW CARBON STEEL IN SULPHURIC ACID

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The effect of inorganic halide on the rate of dissolution of a low carbon steel in sulphuric acid solutions was discovered rather long ago. It was found that inorganic iodine-compounds are the most effective inhibitors of dissolution, followed by bromide compounds while the least active are chlorine compounds. Most of the researchers, however, used potassium halide (or most of them sodium halide as inhibitors, without considering the role of cations in such compounds. The aim of this work, therefore, was to examine the effect of cations of different electronic structures, on the inhibiting action of iodide and bromide work was carried out with samples of 50 x 15 x 1 mm of low carbon steel 0.2 (Steel 20). The corrosion medium was 2N solution of sulphuric acid. The tests were performed at room temperature by the volumetric method, i. e. by measuring the volume of the released hydrogen. The cations used were of different elements according to the filling of the sub-shells s,p and d. These may be referred to as elements of s,p and d groups. Potassium 2,2,6,2,6,2 calcium 2,2,6,2,6,1 and magnesium 2,2,6,2 were chosen out of s elements.

It is known that the first two of these elements (Potassium and Calcium) have the sub-level 3 d unfilled, K-$3s^2 3p^6 3p^6 3d^\circ 4s^1$, Ca-$3s^2 3p^6 3d^\circ 4s^2$ while magnesium has a normal filling. Mg-$2s^2 p^6 3s^2$ aluminium and tin were examined as the cations belonging to p-elements. Al-$3s^2$ $3p^1$ and Sn-$5s^2$ $5p^2$. Chromium out of elements Cr-$3d^5$ 5s. All the halides used were chemically pure.

RESULTS

Since all previous work was done mostly with potassium iodide taken in various concentrations, the experimental work was started to establish the minimum protective concentrations of potassium iodide required in millimoles of the substance.

The minimum concentration necessary for the most effective inhibition of dissolution was found to be 30 m-moles. Therefore, all further work was done by taking 30 m-mole of halide cmpounds in 2N solution of H_2SO_4.

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The reeults of the experiments with iodide are given in Table I

TABLE I

Time mints		P--elements SnI_2	SnI_4	AlI_3	d-elements CrI_3	KI	s-elemente CaI_2	MgI_2	H_2SO_4
10		0.0	0.0	0.2	0.2	0.6	0.4	0.9	2.5
10	,,	0.0	0.0	0.4	0.4	1.2	1.0	1.8	7.9
10	,,	0.0	0.0	0.6	0.6	1.5	1.4	2.3	15.9
30	,,	0.05	0.0	0.8	0.9	2.4	1.9	9.2	29.4

These data show that iodide with cations of the elements of p and d groups have the most effective inhibiting properities. Particularly effective were bivalent and tetravalent tin compounds followed by aluminium compounds. Chromium conmpounds were particularly effective among the d elements.

In the s group elements the most effective were calcium cations followed by potassium cations. They have the level 3 d° unfilled. Magnesium cations (with normal filling) has little effect.

Similar results, were obtained for bromide (Table II). However, the inhibiting effect of these compounds is much smaller as compared to the effect of iodide.

TABLE II

Time	Solutions	p-Elements	d-Elements		s-Elements	
Mins.	H_2SO_4	$AlBr_3$	$CrBr_3$	KBr	$CaBr_2$	$MgBr_2$
10	2.5	2.1	0.9	2.35	2.6	3.0
10	7.9	5.2	2.4	7.8	6.8	8.4
10	15.9	11.9	4.2	14.0	12.0	15.0
30	28.0	20.0	9.2	25.0	20.0	26.5

It is possible to explain the phenomenon by the fact that the bromine atom has a normal filling of all the sub-levels whereas in the case of iodine the sub-level 'f' is not filled.

CONCLUSIONS:

(1) Work has been done in respect of iodide and bromide with the cations of s, p and d elements as inhibitors of low carbon steel corrosion in the 2N. solution of sulphuric acid.

(2) The effect of cations on the inhibiting action of iodide and bromide has been found.

(3) It has been found that iodide and bromide with the cations of d and p elements are more effective as inhibitors of steel dissolutions in sulphuric acid solutions than the cations of s--elements.

(4) In both groups the elements with unfilled sub-levels are more effective than those with normally filled sublevels.

(5) Bromide have less inhibiting properties than Iodide.

(6) It is possible to account for the fact that sub-levels in the case of bromine atoms are normally filled, where as in the case of iodine, the sub-levels "4f" is not filled.

Further work is in Progress.

ELECTROMETRIC STUDIES ON POTASSIUM AQUA PENTACYANIDE*

PART I. Reduction of the compound at the d. m. e.

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Potassium ferrocyanide undergoes hydrolytic decomposition in a number of ways, viz., by the action of light, heat and dilute acids[1-5] resulting in the formation of potassium aqua pentacyanide. Example of such a decomposition are also met with when potassium ferrocyanide solution is brought in contact with small amounts of metal ions. Thus Pinter[6] observed that Hg^{+2} in slightly acidic solution catalysed the solution of prussion blue from alkali ferrocyanide while Asperger[7-8] observed that the addition of samall amount of $HgCl_2$ (ordered 10^{-5} M) had the same influence as the ultra violet light on the decomposition of potassium ferrocyanide. Malik[9-10] during the course of his studies on the interaction of Cr^{+3} with potassium ferrocyanide got evidence of the decomposition of potassium ferrocyanide into aqua pentacyanide by the addition of small amount of Cr^{+3}.

From the existing literature it has been found that electrometric studies on potassium aqua pentacyanide has not been undertaken as yet although quite a few references are available on the corresponding hexacyano compounds. It was, therefore, thought worthwhile to carry out systematic and comprehensive studies on the electro-chemical behaviour of this compound. In this paper the results on the polarographic reduction of potassium aqua pentacyanide at the dropping merucry electrode are being communicated.

EXPERIMENTAL

REAGENTS:

The compound was prepared employing Hoffmann's method[11] with some modifications. To 200 ml. of potassium ferrocyanide solution (containing 10 gms. of the reagent) was added 1 gm. of potassium carbonate. The mixture was kept in an ice bath and chlorine gas passed through it for about 24 hours till a red coloured solution was obtained. The solution was treated with four times oxygen free cold ethyl alcohol. A yellow precipitate was obtained. It was collected on the Buchner funnel (the filtration was carried out in an atmosphere of hydrogen; the whole apparatus was wrapped with black paper to avoid the action of light on the compound.) The precipitate thus obtained was treated with ice cold mixture of hydroxylamine hydrochloride and sodium carbonate (15 gms. and 10 gms. respectively dissolved in minimum quantity of distilled water) and kept in an ice bath for about half an hour to complete the reaction. The whole mass was then treated with three times of oxygen free ice cold ethyl alcohol. Gray coloured crystals separated out; these were dissolved in small quantity of distilled water and again crystallised with cold ethyl alcohol. The crystallization was repeated three times with ethyl alcohol to obtain the pure product. The aquous solution of the compound became faint yellow on standing for several days; no turbidity, however, appeared even after several weeks.

BUFFERS:

Phosphate buffers[12] were prepared by mixing appropriate amounts of mono-, di-, tri-, sodium phosphate (O.1M) solutions.

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*Primilinary experiments were performed at Chemistry department of Roorkee University, Roorkee.
*Chem. Deptt. Rama College, Pilibhit.

APPARATUS AND PROCEDURE:

Toshniwal manual polarograph type CLO2(India)was used in the prelimanary stage of the work. In latter studies LP55A Professor Heyrovsky polarograph was employed used (as a manual instrument after detaching the recording assembly; Scalamp PYEgalvanometer was used) in the external circuit. The results with both the instrument were wuite comparable. The Lingane and Laitinen polarographic cell and the reference electrode (S. C. E.) were kept immersed in the thermostatic water bath maintained at 30± 0.1°C. Triple distilled mercury was used for the dropping mercury electrode. Since nitrogen was not available pure hydrogen was used to maintain an inert atmosphere in the cell. Combridge Bench Type pH meter with appropriate glass electrodes was used to measure the pHvalue. The same capillary (Fischer make) was used in all the experiments. It had drop time of 4.2 Sec. and with a value of 2.018 for $m^{2}/_{3}\ t^{1}/_{6}$ (hight of the reservoir 57 cm.).

5 cc. of .02M potassium aqua pentacyanide (assuming the formula to be K_3 ($FeCy_5\ H_2O$) was taken in the cell and the volume made up to 20 cc. by adding 2 cc. (1M) supporting electrolyte and the requisite amount of double distilled water. For experiments carried out at different pH the buffer was used instead of distilled water to make up the total volume. Potassium chloride, sodium chloride and lithium chloride were used as supporting electrolytes.

A few experiments were performed with samples of potassium ferrocyanide and potassium aqua pentacyanide (both 0.02M) exposed to white and ultra violet light. Gallenkemp Ultra Violet Lamp was used for irridating the samples.

RESULT AND DISCUSSION

Potassium aqua pentacyanide is reduced at the dropping mercury electrode in two steps with the following half wavepotentials in the different supporting electrolytes. $E_{1/2}$-0.14; -0.16 and -0.15V. For the first wave; and - 0.53, - 0.90 and -0.66 for the second wave in potassium chloride, sodium chloride and lithium chloride respectively. Analysis of wave shows that wave one is reversible corresponding to one electron transfer reaction (the reversibility was tested by Tomes method[12] and by plotting log (i/id - i) against E[13]. The number of electrons involved in the reduction was derived from the Ilkovic expression $n=I/605\ D^{1/2}$, where $I=id/Cm^{2/3}t^{1/6}$. The value of I, the diffusion current constant, was found to vary with concentration, higher values being obtained at lower concentration. The value of the diffusion coeficient was calculated from the aquivalent conductance with the aid of the equation[14] $D=2.67\times10^{-7}/Z$.taking $\lambda=160$ mhos at infinite dilution and Z=3, $D=14.23\times10^{-6}$. The value of then comes out to be 1/2.27; n=0.894.

Hence the reduction of potassium aqua pentacyanide can be assumed to be a one electron transfer reaction and the reaction may be represented as:

$$\underset{II}{(Fe\ Cy_5H_2O)^{-3}} + e) \quad \underset{I}{(FeCy_5\ H_2O)^{-4}}$$

As for the second wave, the probable reduction at the d.m.e. may be into Fe (0):

$$\underset{I}{(Fe\ Cy_5H_2O)^{-4}} + e) \quad (Fe^{\circ}(Hg) + H_2O + 5CN^{-}$$

Polarograms in different buffers give two waves in the pH range (2.0-10.0). The first wave is reversible upto pH 5.0 after which both the waves becomes irreversible. The results are tabulated in the following table.

TABLE I

E 1/2 and I values for the reduction of aqua pentacyanide in different buffers using Licl as the supporting electrolyte.

pH	NATURE OF WAVE		E 1/2		I
	WAVF I	WAVE II.	WAVE I.	WAVE II.	
2.0	Reversible	Irreversible	—.12	—1.02	2.03
3.0	,,	,,	—.14	—1.0	2.01
3.4	,,	,,	—.14	—.98	1.99
4.0	,,	,,	—.16	—.96	1.97
4.6	,,	,,	—.18	—.94	1.94
5.0	,,	,,	—.90	— .90	1.92
7.0	Irreversible	,,	—.16	—.80	1.62
8.7	,,	,,	—.16	—.96	—
9.2	,,	,,	—.16	—.80	—

From the curve between pH and I it is seen that a sudden decrease in the value of I takes place beyond pH-5. This is also supported by the fact that the first wave becomes irreversible after this pH.

The irridation of potassium aqua pentacyanide by ultra violet light or an exposure to electric bulb (500 watts) transforms the first wave (originally reversible) into an irreversible one. Such an effect is, however, not observed on exposing the solution to direct sunlight (4 hours). It means that the compound potassium aqua pentacyanide is light sensitive. The results on the E 1/2 values of the irrdated product are summarised below.

TABLE II.

E 1/2 valves of light exposed samples of potassium aqua pentacyanide (0.005M) in 1M Licl.

SAMPLE	NO OF WAVE	E 1/2	
		WAVE I	WAVE II
Unexposed.	2	—0.16	—0.90
Exposed to U.V.Light	2	—0.24	—0.92
Exposed to light from electric bulb.	2	—0.28	—0.92
Exposed to sunlight	2	—0.17	—0.94

It is rather interesting to note that potassium ferrocyanide exposed to light from electric bulb (4 hours) gave two waves with E 1/2=0.16 and -0.90. The same values as for unexposed potassium aqua pentacyanide.

Further work is in progress.

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CONTENTS

AMINO-ACID AND PROTEIN CONTENTS OF SOME MEDICINAL PLANTS OF KUMAON REGION

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ABSTRACT

Cysteine, ornithine, asparagine, glycine, glutamic acid, threonine, α—alanine, β—alanine and nor-valine have been identified from the fruits of *Arisaema Curvatum*, *Cupressus torulosa D. Don*, *Eucalypulus globulus* and roots of *Arisaema Curvatum*. The amino acids present in the from of proteins were examined from the above plants and reported to contain cysteine, ornithine, asparagine, glycine, glutamic acid, threonine, α—aianine, β—alanine, proline. tryptophan, leucine, nor-leucine, iso-leucine and nor-valine. Asparagine, threonine and β—alanine remained unaffected when the protein hydrolysate of *Cupressus torulosa* was heated upto 200° C for 1 hour .

INTRODUCTION

Arisaema Curvatum, *Cupessus torulosa D. Don* and *Eucalyptus globulus* pos·ess high inseciticidal properties[1,2] . The essential oils from Cupressus torulosa D. Don[3] and Eucalyptus globulus[4]have been studied by a number of workers . However, no work seems to have been done with regard to amino-acids and proteins present in the roots of *Arisaema Curvatum*, and fruits of *Arisaema Curvatum*, *Cupressus torulosa D. Don* and *Eucalyptus globulus* . The present communication concerns with the isolation and identification of free amino-acids and proteins present in different parts of the aforesaid plants .

MATERIAL AND METHODS

Free amino acids were extracted from the plant material (10 gm) with 70-80% ethanol (50 ml) and the total protein, which was extracted with trichloro-acetic acid (25 ml of 30% solution in water) was then purified by acetone[5] . The protein hydrolysis was carried out with 6N HCl in an autoclave at 15 mm for 1 hour . Excess HCl was then removed in a vacuum desiccator using . KOH as absorbent . The solutions were analysed for amino acids by descending paper chromatographic technique (employing whatman filter paper No. 1. 22.5 × 18.5") . η—Butanol-acetic acid-water (4:1:1 V/V.) was used as a solvent system .

Ninhydrin[6] (0.1% in acetone), isatin[7,8], (0.4% in η—butanol containing 4% acetic

acid) and Folin's reagent[9] (0.02% sodium napthoquinone-4-sulfonate) were used for detection . The amino acids were estimated by using photoelectric colorimeter at 570 mμ.[10] The total protein was determined by micro-kjeldahl's method.[11] The percentage of nitrogen in the sample was multiplied by 6.25 to obtain the protein content.[12]

RESULTS

The need of maintaining the protein quality and quantity has been well recognized . The fruits of *Eucalyptus globulus*, *Cupressus torulosa D. Don* and *Arisaema Curvatum* and roots of *Arisaema Curvatum* had been found to contain an appreciable amount of protein and the percentages were 7.5, 8.75, 10.0, 13.5 respectively .

The plants were found to contain nine amino acids in free state and on hydrolysis, number increased to fourteen . The results recorded in Tables 1 and 2 clearly show the presence of amino acids in these plants both in free as well as in the combined from . The identity of amino acids were confirmed by comparing the chromatographically separable ninhydrin, isatin and Folin's reagent products with authentic amino acids, coincidence chromatography and by comparing the resolution factors of these products with reference to amino acids (Tables 1 and 2). Further, product VIII (fig. 2a) or VI (fig 2e) was confirmed as α—alanine by its Oxidative deamination with nitrous acid to acetaldehyde . Proline was confirmed by its appearance as bright red spot on the Chromatogram on spraying with a 2% solution of Vanillin in η—propanol. Product VI (fig. 2a & b) or III (fig. 2c) or IV (fig. 2e) gave periodate test[13], and was characterised as threonine, while the product VII (fig, 2c) whice gave a voilet colouration with p—dimethylaminobenzaldehyde was confirmed as tryptophan .

The root of *Arisaema Curvatum* was found to contain traces of cysteine, glutamic acid, threonine and β—alanine in free state . On hydrolysis, the yield of all these four amino acids were found to increase, showing their presence as a part of proteins . Similarly five amino acids (Table 1) were detected in free state in fruits and on hydrolysis three more acids were recorded (Table 2a) .

Fruits of Eucalyptus globulus contain four amino acids in free state (Table 1) and on hydrolysis it gave in all seven acids (Table 2b) in which the free amino acids were common . The fruits of Cupressus torulosa D. Don were found to contain asparagin, glutamic acid, threonine and β—alanine in free state . On nydrolysis it, however, gave proline, tryptophan and leucine . When the hydrolysate of *Cupressus torulosa D. Don* was heated upto 200° C for 1 hour, only asparagine, threonine and β—alanine were left in the solution .

From the results present, it may be concluded that the aforesaid plants contain an appreciable amount of protein as well as free amino-acids .

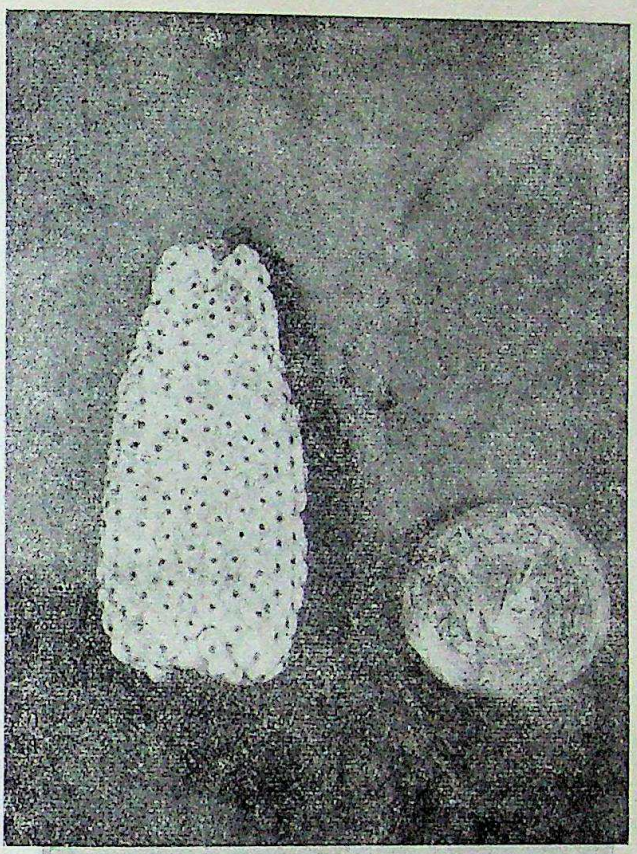

Fig. 1 a)

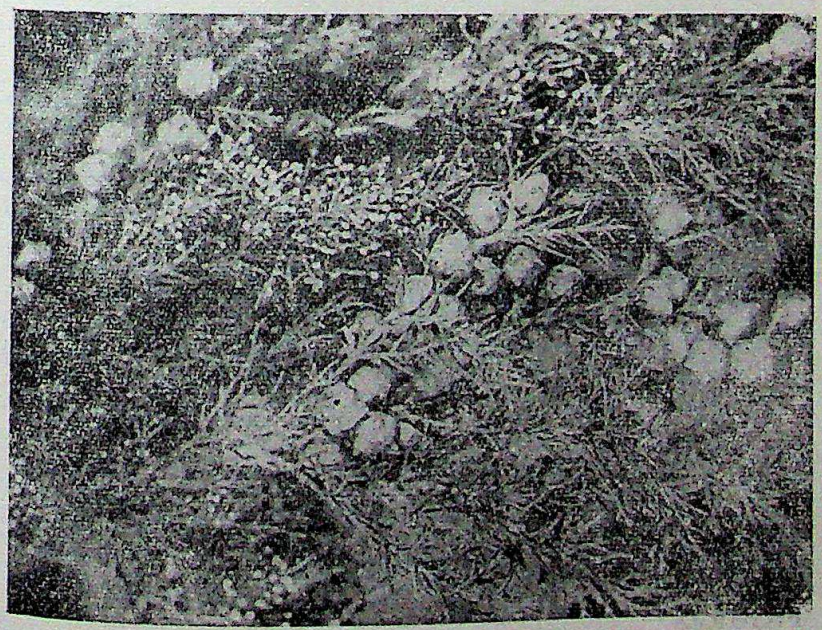

Fig. 1(b)

Fig. 1(c)

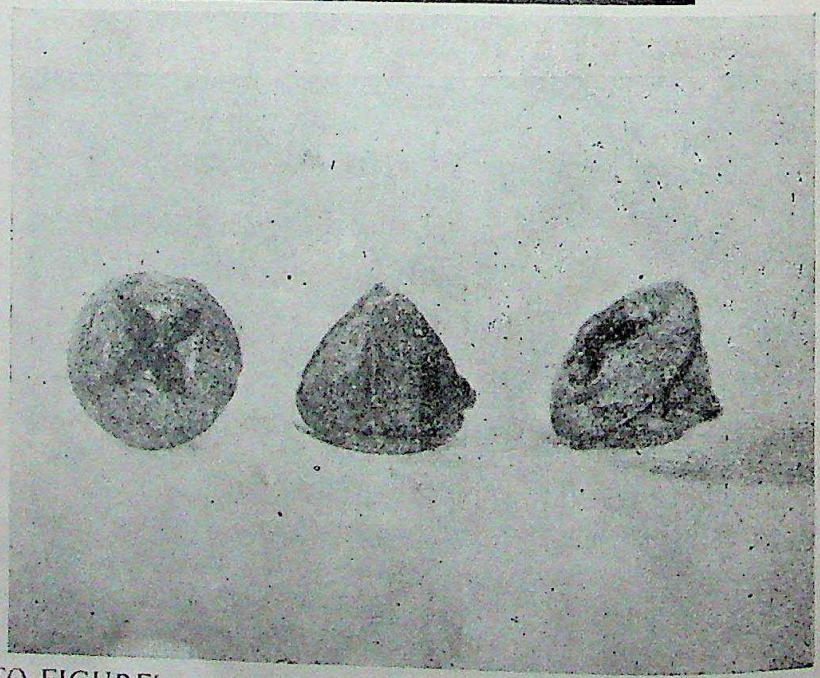

Fig. 1(d)

LEGENDS TO FIGURES

Fig. 1 ;— (a)The fruits and roots of Arisaema Curvatum, (b) the photograph of the Cupressus torulosa D. Don, (c) the leaves of the Eucalyptus globulus (d) and the fruits of Eucalyptus globulus .

TABLE 1.

Amino acids identified from the roots of *Arisaema Curvatum*, fruits of *Arisaema Curvatum*, *Cupressus torulosa D. Don* and *Eucalyptus globulus* in free state .

Sl. No.	Name of plant	Part of the plant used	Amino acids identified
1.	Arisaema Curvatum	Roots	Cysteine, glutamic acid, threonine & β—alanine .
2.	Arisaema Curvatum	Fruits	Cysteine, glutamic acid, proline, α—alanine & nor-valine .
3.	Cupressus torulosa	Fruits	Asparagine, glutamic acid, threonine & β—alanine .
4.	Eucalyptus globulus	Fruits	Ornithine, glutamic acid, threonine & β—alanine .

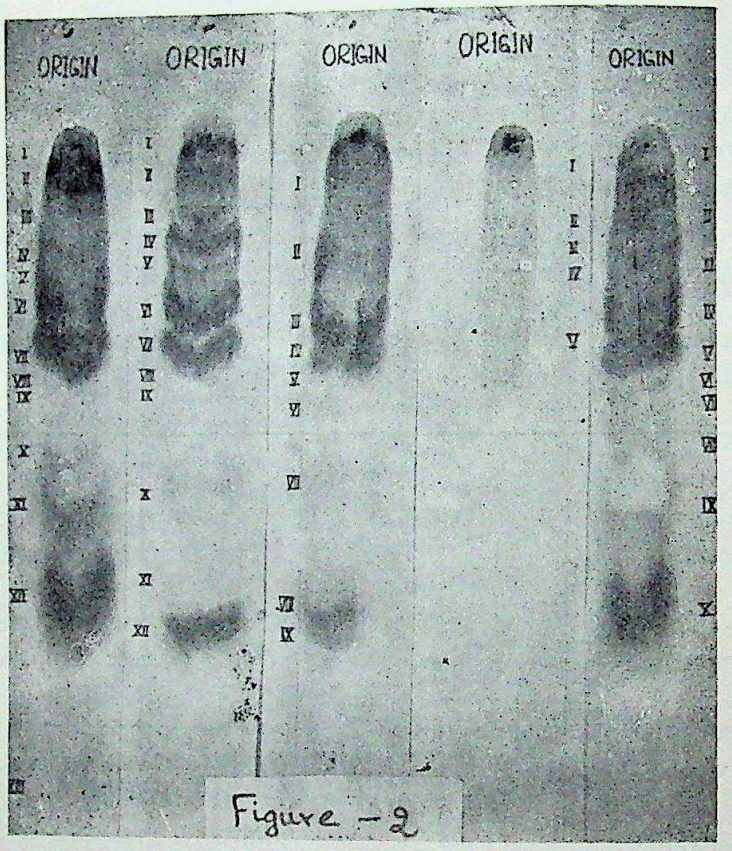

Fig. 2 ;— Ninhydrin sprayed chromatogram showing the formation of amino acids from fruits of Arisaema Curvatnm after hydrolysis (a), fruits of Eucalyptus globulus after hydrolysis (b), fruits of Cupressus torulosa D. Don. after hydrolysis (c) fruits of Cupressus torulosa D. Don after hydrolysis and destruction at 200° C (d) and roots of Arisaema Curvatum after hydrolysis (e) .

Solvent system used was n—butanol - acetic acid-water (4 : 1 : 1, v/v) and the colour was developed after heating the chromatogram at 60° C.

TABLE II

Properties of the chromatographically separable products obtained from the fruits of *Arisaema Curvatum* after hydrolysis (Fig. 2, a); fruits of *Eucalyptus globulus* after hydrolysis (Fig. 2, b);fruits of *Cupressus torulosa D. Don* after hdrolysis (Fig. 2, c); fruits of *Cupressus torulosa D. Don* after hydrolysis and heating at 200° C (Fig. 2 ,d) and roots of *Arisaema Curvatum* after hydrolysis (Fig. 2, e).

Sl. No.	Fig. 2 pro-duct No.	Fig. 2, a Colour with Nin	Isa	F	Amino Acid Identified	R_f	Yield %	Fig. 2, b Colour with Nin	Isa	F	Amino Acid Identified	R_f	Yield %	Fig. 2, c Colour with Nin	Isa	F	Amino acid Identifeied	R_f	Yield %	Fig. 2, d Colour with Nin	Isa	F	Amino acid Identified	R_f	Yield %	Fig. 2, e Colour with Nin	Isa	F	Amino acid Identified	R_f	Yield %
1.	I	V	Br	GrB	—	—	—	V	P	GrB	—	—	—	O	—	IB	Asparagine	0.10	1.26	V	P	BGr	—	—	—	V	Br	BGr	—	—	—
2.	II	R	RV	dB	Cysteine	0.05	0.44	V	—	B	Ornitnine	0.095	0.56	V	G	BGr	Gl. Acid	0.20	1.88	O	—	IB	Asparagine	0.10	0.68	V	RV	dB	Cysteine	0.05	0.72
3.	III	RV	BrP	GrB	Glycine	0.15	0.48	V	Br	BGr	—	—	—	BrV	RBr	G	Threonine	0.22	0.94	BrV	RBr	G	Threonine	0.22	0.40	V	G	BGr	Gl. acid	0.20	1.6
4.	IV	V	G	BGr	Gl. acid	0.20	0.89	RV	BrP	GrB	Glycine	0.15	0.38	BV	—	B	β—alanine	0.25	0.45	V	Br	Gr	—	—	—	BrV	RBr	G	Threonine	0.22	1.03
5.	V	V	P	GrB	—	—	—	V	G	BGr	Gl. acid	0.20	0.58	V	Br	Gr	—	—	—	BV	BV	B	β—alanine	0.25	0.15	BV	BV	B	β—alanine	0.25	0.45
6.	VI	BrV	RBr	G	Threonine	0.22	0.56	BrV	RBr	G	Threonine	0.22	0.094	Y	B	R	Proline	0.36	0.29							V	dB	GrB	α—rlanine	0.29	0.19
7.	VII	BV	BV	G	β—alanine	0.25	0.02	BV	BV	B	β—alanine	0.25	0.35	V	OBr	BrGr	Tryptophan	0.40	0.65							Y	B	R	Proline	0.36	0.16
8.	VIII	V	dB	GrB	α—alaniue	0.29	0.28	V	Br	GrB	—	—	—	V	Br	BGr	—	—	—							Y	Br	Gr	—	—	—
9.	IX	Y	B	R	Proline	0.36	0.11	Y	B	R	Proline	0.36	0.45	V	RV	GrB	Leucine	0.68	0.06							V	B	GrB	Neo-leucine	0.57	0.40
10.	X	V	Br	Gr	—	—	—	Y	P	Gr	—	—	—													V	RV	Gr	Iso-leucine	0.64	0.50
11.	XI	YV	Br	—	—	—	—	V	Br	BGr	—	—	-																		
12.	XII	V	VB	Gr	nor-valin	0.56	0.80	V	RB	GrB	Leucine	0.68	0.50																		
13.	XIII	V	Br	BGr	-	—	—																								

Nin - Ninhydrin, Isa - Isatin, F-Folin's reagent, Gl. acid=Glutanic acid
V-Voilet, B-Blue, Y-Yellow, P-Pink, G-Green, O-Orange, R-Red, Br-Browm, d-dark, I-Indole, Gr-Grey .
Using solvent n-butanol : acetic acid : water (4 : 1 : 1 Vol/Vol,) at temperature 15±5° C

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DEPENDENCE OF THE JOSHI EFFECT ON THE NATURE OF THE CURRENT DETECTOR

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ABSTRACT

Study of the 'falling current-potential (i-V) characteristics' and the Joshi effect—$\triangle i$ in mercury vapour contaminated hydrogen was carried out with various detectors—1N34 (Sylvania), OA81 (Philips), microammeter, vacuo-junction, 6H6 and Triode 30 . The potential at which the falling i-V characteristic began was highest for vacuo-junction, lowest for diode and that for crystal lying in between . The potential range of occurrence of falling i-V was also in the same order . Discharge current iD at the threshold potential was more for crystal than that for diode—vacuo-junction having the lowest value . Potential for maximum relative Joshi effect—$\%\triangle i$ was the highest for the vacuo-junction, next the crystal and the lowest for the diode . However, the magnitude of—$\%\triangle i$ was in the reverse order . Maximnm—$\%\triangle i$ occurred nearly at the same potential where iD reached a maximum before the commencement of the 'negative characteristic' . The observed falling characteristic is ascribed to an increase in the space charge .

INTRODUCTION

Townsend[1] and Werner[2] showed that the current is a function of both the applied potential V as well as the 'over-voltage' ($V—V_m$) . During the study of the Joshi effect $\triangle i$, an almost instantaneous and reversible photo-variation (generally decrease) of the discharge current i, in air, argon and hydrogen, a decrease, however, of the current i (D,L) was observed with the increase of the applied potential over certain range, i. e. a negative or falling current-potential characteristic was observed . A similar 'falling characteristic' in mercury vapour contaminated hydrogen at 59 mm, 30° C developed as a result of 284 hours 'aging'—continued exposure to discharge at a fixed applied potential, and was observable after even 624 haurs of 'rest'—keeping the tube unexcited at room temperature (30° C) . It was, theefore, of interest to investigate the falling characteristeristic and the associated Joshi effect in mercury vapour contaminated hydrogen with various detectors in greater detail .

EXPERIMENTAL

The discharge was produced in the annular space (4 mm × 135 mm) of the glass, Sigcol 'S 75' ozonizer of Siemen's type . The electrical circuit employed for exciting the ozonizer and the current measurement was as shown in Fig. 1.

A 200 watt, 200 volt incandescent (glass) lamp enclosed in a wooden box with sliding shutter, kept at 25 cm from the ozonizer, served as the source of irradiation . The discharge cyrrent was measused by screening on (i_D) and off (i_L) the light source . i_L—i_D is the net Joshi effect ($-\Delta i$). The relative Joshi effect ($-\%\Delta i$) is given by:

$$-\%\Delta i = (-\Delta i/i_D) \times 100.$$

The discharge current i was measured with the following detectors included in the low tension line of the ozonizer: (1) (i) Cu/CuO (half wave rectifier), 1N34 Sylvania (Circuit1 -a-a-1); (ii) Ge/Geo (half wave rectifier), OASI Philips (Circuit 1-b-b-1) Cupper oxide (double wave rectifier), A. C. microammeter (Circuit 2-2); (2) Vacuo-junction—"Cambridge", 1.25mA, 1566 ohms, (Circuit 3-3) (3) (i) Double diode (half wave rectifier), 6H6 R. C. A. (Circuit 4-4-4-4); and (ii) Triode 30—used as a diode (Circuit 5-5-5-5) .

RESULTS

The 'falling-current characteristic' with all the detectors employed was well marked, i e. as the applied potential was increased progressively above the threshold potential V_m—at which the gas breaks down as a dielectric and which is characterised by a sudden increase of the discharge current i or its inception as the applied potential kV is increased slowly from a small value with simultaneous appearance of a characteristic glow in the discharge tude, the discharge current initially increased to a maximum, after which it diminished to a minimum value and finally increased as the applied potential was increased. As the behaviour of qne detector in any one of the above groups was the same ast hat with the other detector in the same group, so for the sake of comparison, 'Crystal' 1N34 (Sylvania) was chosen as a representative af the typical class of 'oxide type rectifiers'. Similarly, 'Double diod', 6H6 represents a typical thermionic tube .

Data of the current i (cf Fig. 2) revealed that the range for occurrence of falling-current characteristic was more in dark (i_D) than that under light (L_i). There was, however, no appreciable change in potential where the falling charactieristic commenced for both i_D and i_L. The potential at which this charactieristic began was highest under vacuo - junction (V. J.) and lowest under diode detection . The potential range for the occurrence of falling characteristic was also in the same order .

It is instructive to emphasise that with all the detectors employed the threshold potential V_m was sensibly the same . Discharge current at V_m was in the order: Crystal > Diode > V. J.

i_D at ($V—V_m$), the net over-valtage, was also in the same arder as that at V_m .

The relative Joshi effect—$\%\Delta i$ first increased to a maximum and then decreased with the enhancement in the applied potential kV . This behaviour of—$\%\Delta i$ with kV was unaffected by the nature of the detector employed (cf. Fig. 3) . Potential at which maximum—$\%\Delta i$ was observed was in the order of: V. J. > Crystal > Diode. However,

the magnitude of the maximum—%$\triangle$i observed was in the reverse order. Maximum—%$\triangle$i occurred nearly at the same potential where i_D reached a maximum before the commencement of the falling—current characteristic.

DISCUSSION

That V_m is a fundamental quantity is brought out by the present study. Despite widely varying methods of current detection, this potential in the above-mentioned system containing about 0.005% mercury vapour as impurity is constant, viz., 0.55 kV, the other factors, i. e., frequency of the a. c. supply and the temperature, etc. being constant.

It was observed that as the applied potential (kV) was raised gradually above V_m, i) first increased to a maximum, i_{D_1} at V_1 and then started falling up to a certain minimum, i_{D_2} at V_2, after which there was a continuous rise. The slope of the first stage (below V_1) and the third (above V_2) was positive and that of the intermediate (V_1 to V_2) negative. This was true for both i_D-V and i_L-V curves as well as for $\triangle$i-V. The ratio of the total fall in the ordinate (X_2—X_1) representing the mean slope (n) may be taken to be a measure of this 'negative or the falling characteristtc'. Thus, $n(i_D) = (i_{D_2}—i_{d_1}) / (V_2—V_1)$, $n(i_L)=(i_{L_2}—i_{L_1}) / (V_2—V_1)$, $n(\triangle i) = (\triangle i_2—\triangle i_1)/ (V_2—V_1)$. The results obtained show that: $n(i_D) > n(\triangle i) > n(i_L)$. This follows from the observed fact that $d(i_D)/dV = d(i_L)/ dV$, and because by definition $d(\triangle i)/dV = d(i_D—i_L)/dV$.

Joshi[3] showed that the discharge current consists of h. f. componets besides the supply freqnency and its harmonics. An oscillographic study of hydrogen under ozonizer discharge revealed[4,5], that the amplitudes of these h. f. components rise with the potential in the initial stage, and at higher potentials decrease, unlike the low frequency (l. F.) and the supply frequency components which go on increasing with the potential throughout the range. The slope of the characteristic becomes negative, it is suggested here, under conditions when the rate of the decrease of h. f. is relatively faster than the rise in the supply and l. f. components. Prasad[6] showed that such an inhibitory effect of high potential specifically on the h. f. components appears probable from Joshi's equation[7] for the discharge current. The current under light being already an h. f. suppressed one, there is lees to be further inhibited by high potential. Hence the lower value of $n(i_L)$ compared with $n(i_D)$.

The apparent variability of the magnitude of the 'effect' with the mode of current detection arises from the selectivity in response of the various detectors to different frequencies in the frequency spectrum of the discharge current.

A crystal detector consists of a crystal in contact with a metal. The boundary between the crystal and the metal possesses a very high resistance, the value of which varies markedly with the direction of the impressed e. m. f., thus leading to rectifi-

cation[8,9]. That the magnitude of $\triangle i$ obtained with crystal detectors is small as compared with the diode might, in part, be due to the appreciable resistance of the rectifier in the low resistance direction, especially at small voltages applied across the instrument.

According to Joshi[2] the vacuo-junctions have a stable characteristic over a wide range of applied potential and frequency of a. c. supply. For very high frequencies, however, a small error due to the 'skin effect' creeps in. Further,since in this mode of current detection an appreciable resistance is introduced, a reduction of h. f. oscillations occurs prior to irradiation. This would reduce $\triangle i$. In a thermal device like the thermo-or vacuo-junction, reduction in $\triangle i$ due to resistive coupling of $i_{h.f.}$ is, however, not appreciable, since the corresponding loss is represented by conversion into heat. Due to the stray capacity between the heater wire and the thermo - couple, on the other hand, high frequencies may find their way into the thermo - couple circuit and may consequently be lost.

The maximum $\triangle i$ obtained with the inductively fed diode is higher than that obtained with the vacuo - junction. This is to be anticipated in view of the low ohmic resistance in the oscillatory cirucuit.

While the occurrence of falling current characteristic is common in the arc and commercial discharge tubes, it is less frequent in the case of glow or the silent electric discharge.

The main feature of a characteristic is the decrease of the current which is unrelated to i. e., inspite of the rising potential. To explain this we have to look for various possible agents besides an accelerating potential that contribute to the current. Pohl's[11] suggestion of fall of resistance due to heating of the electrolyte by passage of the electric current is not adequate to explain the negative characteristic in the case of gaseous conduction where numerous accessory factors operate besides the heating effect. In the case of an arc discharge with metal electrodes, thermionic emission from the later may be looked upon as a source of additional conductivity. In the case of an all glass ozonizer, however, such an emission is not easily understandable; these conditions, however, bare on the occurrence of $\triangle i$. Thus there is a difficulty in accounting for the origin of the negative segment of the i—V characteteristic, particularly for an ozonizer discharge.

For explaining the occurrence of the falling i—V characteristic in hydrogen, Jatar[5] has considered two cases: (i) a variation of, the second Townsend coefficient with X, (ii) the field X, and (iii) an increase in the electron current between the plates according to the equation $di = edn = e(n\alpha dX + cn^2dX)$ instead of $edn = e\alpha ndX$. He argues that the variation of γ with X is atleast but a minor factor responsible for the 'falling charcteristic'. The second possibility was tested experimentally for the rare gases by Schade[12] and Butler[13]. According to these authors, the term with n^2 in the above equation is due to the collision between two metastable atoms leading to the ionization of one of them. Evidence in support of this is obtained from the right order

of magnitude of the effect and its independance on p as also from the desrease in the slope of the characteristic when small amounts of argon are added to Ne to destroy the metastables. On this hypothesis, if the Ne discharge is illuminated by Ne light, the slope of the characteristic should decrease due to a decrease in the concentration of the metastables. This, however, proved not to be true, in hydrogen, the hypothesis depending on metastables does not appear to be likely.

Druyvesteyn and Penning[14] ascribe the 'falling characteristic' of the corona discharge between co-axial cylinders to the positive space charge. During the threshold field studies of various positive corona phenomena in air at atmospheric pressure, Fitzsimmons[15] observed a marked 'negative characteristic' when the gas was poorly ventilated or in air of 65% relative humidity at 20° C. He found that when the ionization products get loose in moist air, space charges rapidly become very large. The resultant of this abnormally rapid space charge chocking is a drop in current until the potential rises to a value where the applied fields can clear out the space charge. The 'falling characteristic' observed in the present study may, therefore, be ascribed to an increase in the density of space charge.

ACKNOWLEDGEMENTS

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PHYSICO-CHEMICAL STUDIES ON THE COMPOSITION AND STABILITY OF LEAD AND 2-HYDROXY-1 4-NAPHTHOQUINONE.

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The interaction of lead and 2-Hydroxy-1, 4-Naphthoquinone has been studied at 25±1°C in an aqueous alcoholic medium conductometrically in the light of Job's continuous variation method[1] and pH-metrically using Bjerrum technique[2]. The graphs indicate the formation of a chelate containing lead and the ligand in the molar ratio of 1:2. From the analysis of pH-metric data and infra-red measurements, a reaction mechanism has been suggested and the formation constant of the chelate has been determined as 8.71×10^8 The free energy change of formation of chelate workes out to be −12.19 Kcal/mole.

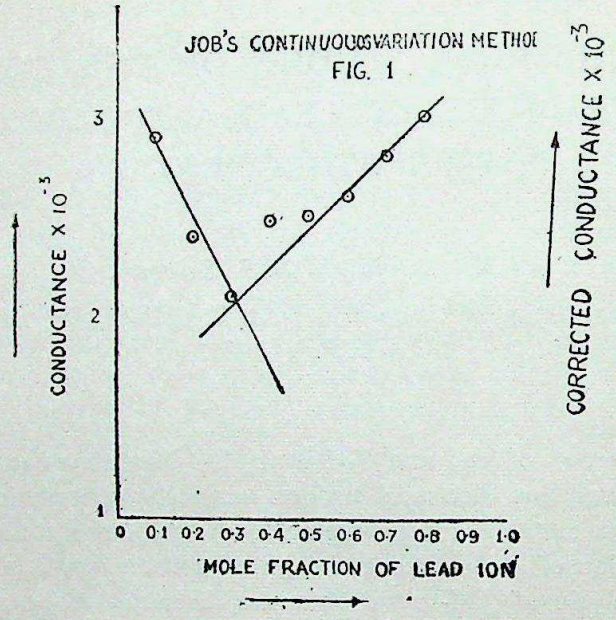
Mangini and Stratta[3] in (1932) reported the preparation of lead salt with 2-hydroxy-1, 4-naphthoquinone. In 1961 Lawsone was introduced as a reagent for inorganic analysis by Yuzo Nagase and Ushiho[4]. Systematic and comprehensive studies of metal - Lawsone chelates have, however, not so far been made. Investigations in this direction are undertaken. The present investigation essentially deals with the establishment of chelate formed between lead ion and Lawsone. The emperical formula of the chelate has been found to be PbR_2 (R=reagent).

EXPERIMENTAL

The ligand used was Lawsone obtained from Fluka A. G. Buche S. C. Lead nitrate was of Analar grade. The reagent was prepared by dissolving Lawsone (w/v) in absolute alcohol. All measurements of conductance were made with conductivity meter type LBR/B. The Beckman pH meter was employed for pH metric titration. For infra-red measurements, Perkin Elmer Infra Cord Spectrophotometer was used.

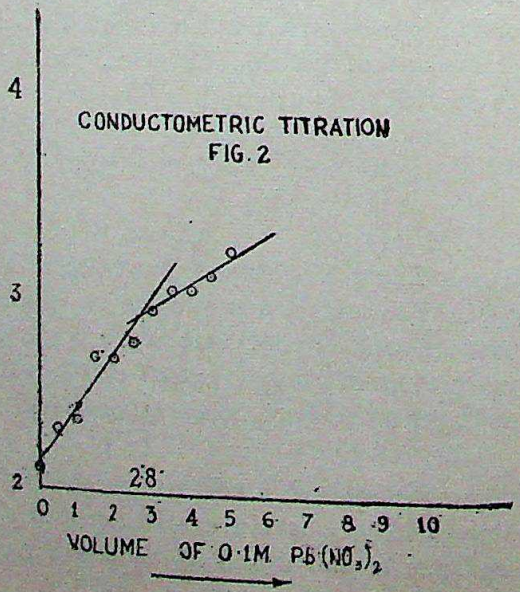
The molecular composition of Lead-Lawsone chelate was determined by applying Job's continuous variation method conductometrically. For Job's method, equimolar solutions of lead nitrate and ligand of concentration 0.004 M were varied

from 1 : 9 to 9:1. A graph between conductance and mole fraction of lawsone was drawn (Fig. 1).



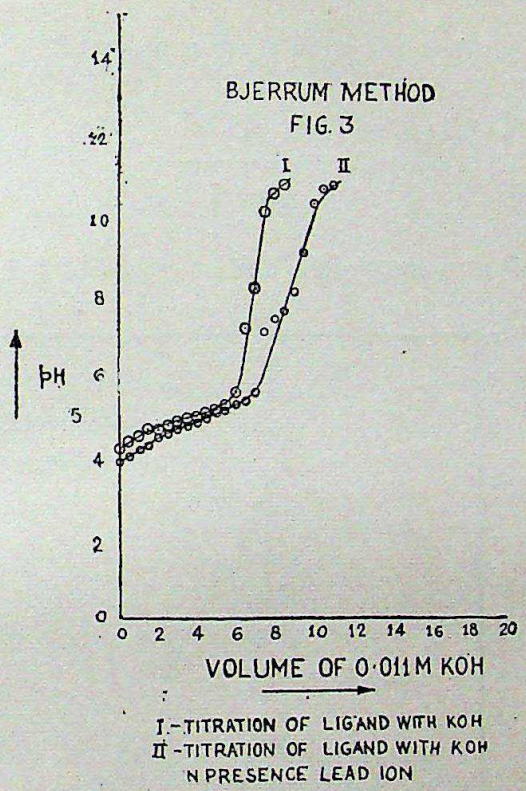
Conductometric Titration

Conductometric titration of Lawsone (15 ml) of concentration 0.04 M was carried out with 0.1 M lead nitrate. On each addition the solution was shaken and allowed to stand for some time before the conductance of the solution was measured. A graph between volume of lead nitrate added and corresponding corrected conductance was drawn (Fig. 2).



pH-metric Titration

20 ml. of Lawsone (0.004 M) with and without 5 ml of 0.004 M lead nitrate was titrated against 0.011 M KOH (Fig 3).



Preparation of Chelate and I. R. measurements

Lead nitrate was taken in a beaker and warmed. From burette, 1% solution of reagent was added slowly and with constant stirring. The colour of the solution became dark brown. The solution was again warmed and concentrated. On cooling, dark brown precipitate appeared. It was filtered, washed with distilled water and dried at 60--70°C in an electric oven.

Infra-red measurements were recorded in solid state by KBr-technique.

Results and Discussions

Conductometric studies show that the composition of chelate formed between lead ion and ligand is 1:2. The pH data for the determination of formation constant by Bjerrum technique are shown in Table I. The n^- (average no. of moles of the ligand bound per metal ion) was evaluated from the graph according to Calvin and Melchior[5]. The concentration of Lawsone anion (L^-) was evaluated from known amount of unc-oordinated ligand and its half titration point of sample of lowsone.

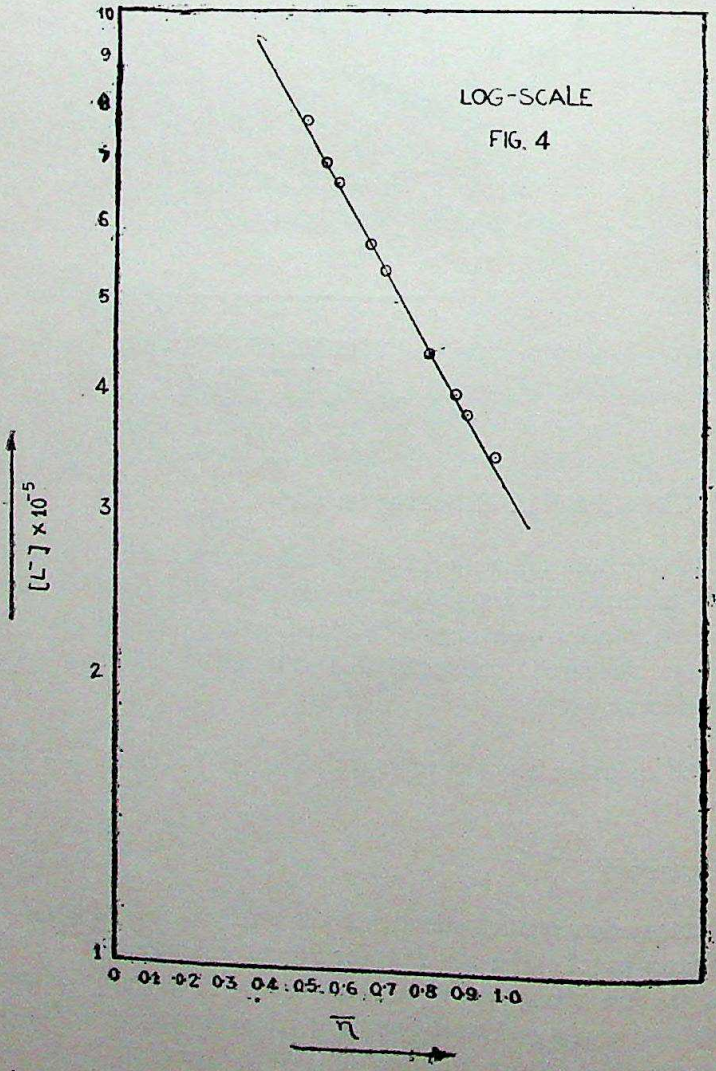
$$LH \rightleftharpoons L^- + H^+$$

$$K_1 = \frac{[L^-]\ [H+]}{[LH]}$$

Where K_1 stands for dissociation constant of ligand.

or $$[L^-] = \frac{K_1\ [LH]}{[H^+]}$$

The values of n^- were plotted against - Log (L^-) (Fig. 4).



The value of -- Log (L^-) at $n^- = 1.00$ was taken as the value of $\frac{1}{2}$ log K (K = formation constant). The value of K has been worked out to be 8.71×10^8.

Table—1

pH data to determine formation constant for lead--Lawsone system in aqueous alcoholic medium at 25±1°C.

Total concentration of lead ion = 8×10^{-4} M
Total concentration of Ligand = 32×10^{-4} M

pH	$(H^+) \times 10^{-4}$	n^-	$(LH) \times 10^{-4}$	$(L^-) \times 10^{-4}$
5.5	3.103	0.376	28.897	1.045
6.0	4.075	0.510	27.925	0.768
6.5	4.446	0.556	27.554	0.695
7.0	4.667	0.583	27.333	0.657
7.5	5.271	0.660	26.729	0.568
8.0	5.547	0.693	26.453	0.535
8.5	6.471	0.810	25.529	0.442
9.0	7.034	0.880	24.966	0.398
9.5	7.291	0.910	24.709	0.380
10.0	7.856	0.982	24.144	0.344

The free energy of formation of chelate from lead nitrate and 2-Hydroxy-1, 4-naphthoquinone is calculated from the relation $\triangle F^\circ = -RT \ln K$ where the terms have their usual significance. In this system the value of $\triangle F^\circ$ worked out to be—12.19 Kcal/mole at 25±1°C. The reaction is accompanied with considerable decrease of free energy at room temperature, indicating spontaneous nature of the reaction.

Chelate Structure

The phenolic group of ligand behaves as weekly acidic and is capable of protonisation. The enolic anion thus liberated satisfies the valency of metal cation, further entering into co-ordination with adjoining keto oxygen as donor. Thus a covalent coordinated complex is formed.

The seats of interaction in the course of chelation have further been ascertained by infra-red measurements. In the spectrum of ligand, the characteristic frequencies at 3125 cm^{-1} and 1650 cm^{-1} correspond to hydroxyl group (_OH) with hydrogen bond and Carboxyl group of Quinonoid type respectively. From the spectrum of lead-Lawsone chelate, these frequencies are lowered to 3030 cm^{-1} and 1626 cm^{-1} respectively. This lowering of frequencies can only be responsible for lead-lawsone binding in the chelation.

The course of reaction leading to chelation is represented as

$$\text{I} \quad 2\,C_{10}H_6O_3 \rightleftharpoons 2\,C_{10}H_5O_3^- + 2H^+$$

$$\text{II} \quad 2\,C_{10}H_5O_3^- + Pb^{+2} \rightleftharpoons C_{10}H_5O_3\text{—}Pb\text{—}C_{10}H_5O_3.$$

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ELECTROMETRIC STUDIES ON POTASSIUM AQUA PENTACYANIDE.

Reduction of the compound at the d. m. e.

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Potassium ferrocyanide undergoes hydrolytic decomposition in a number of ways, viz., by the action of light, heat and dilute acids [1–5] resulting in the formation of potassium aqua pentacyanide. Example of such a decomposition are also met with when potassium ferrocyanide solution is brought in contact with small amounts of metal ions. Thus Pinter [6] observed that Hg^{+2} in slightly acidic solution catalysed the solution of prussion blue from alkali ferrocyanide while Asperger [7–8] observed that the addition of small amount of $HgCl_2$ (order of 10^{-5} M) had the same influence as the ultra violet light on the decomposition of potassium ferrocyanide. Malik [9–10] during the course of his studies on the interaction of Cr^{+3} with potassium ferrocyanide got evidence of the decomposition of potassium ferrocyanide into aqua pentacyanide by the addition of small amount of Cr^{+3}.

From the existing literature it has been found that electrometric studies on potassium aqua pentacyanide has not been undertaken as yet although quite a few references are available on the corresponding hexacyano compounds. It was, therefore, thought worthwhile to carry out systematic and comprehensive studies on the electrochemical behaviour of this compound. In this paper the results on the polarographic reduction of potassium aqua pentacyanide at the dropping mercury electrode are being communicated.

EXPERIMENTAL

REAGENTS

The compound was prepared employing Hoffmann's method[11] with some modifications. To 200 ml. of potassium ferrocyanide solution (containing 10 gms. of the reagent) was added 1 gm. of potassium carbonate. The mixture was kept in an ice bath and chlorine gas passed through it for about 24 hours till a red coloured solution was obtained. The solution was treated with four times oxygen free cold ethyl alcohol. A yellow precipitate was obtained. It was collected on the Buchner funnel (the filtration was carried out in an atmosphere of hydrogen; the whole apparatus was wrapped with black paper to avoid the action of light on the compound). The precipitate thus abtained was treated with ice cold mixture of hydroxylamine hydrochloride and sodium carbonate (15 gms. and 10 gms. respectively dissolved in minimum quantity of distilled water) and kept in an ice bath for about half an hour to complete the

reaction. The whole mass was then treated with three times of oxygen free ice cold ethyl alcohol. Gray coloured crystals separated out; these were dissolved in small quantity of distilled water and again crystallised with cold ethyl alcohol. The crystallization was repeated three times with ethyl alcohol to obtain the pure product. The aquous solution of the compound became faint yellow on standing for several days; no turbidity, however, appeared even after several weeks.

BUFFERS

Phosphate buffers[12] were prepared by mixing appropriate amounts of mono--, di-, try-, sodium phosphate (0.1M) solutions.

APPARATUS AND PROCEDURE

Toshniwal manual polarograph type CLO2 (India) was used in the prelimanary stage of the work. In latter studies LP55A professor Heyrovsky polarograph was employed (used as a manual instruments after detaching the recording assembly; Scalamp PYE galvanometer was used in the external circuit. The results with both the instruments were quite comparable. Electrode (S. C. E.) were kept immersed in the thermostatic water bath maintained at 30 $\mp$ 0.1°C. Triple distilled mercury was used for the dropping mercury electrode. Since nitrogen was not availble pure hydrogen was used to maintain an inert atmosphere in the cell. Cambridge Bench Type pH meter appropriate glass electrodes was used to measure the pH value. The same capillary (Fischer make) was used in all the experiments. It had drop time of 4.2 Sec. and with a value of 2.018 for $m^{2/3}\ t^{1/6}$ (height of the reservoir 57 cm.).

5 cc. of .2M potassium aqua pentacyanide (assuming the formula to be $K_3Fe\ CN_5\ H_20$.) was taken in the cell and the volume made up to 20 c c. by adding 2 c c. (1M) supporting electrolyte and the requisite amount of double distilled water. For experiments carried out at different pH the buffer was used instead of distilled water to make up the total volume. Potassium chloride, sodium chloride and lithium chloride were used as supporting electrolytes.

A few experiments were perfoamed with samples of potassium ferrocyanide and potassium aqua pentacyanide (both 0.02M) exposed to white and ultra violet light. Gallenkemp Ultra violet Lamp was used for irridating the samples.

RESULTS AND DISCUSSION.

Potassium aqua pentacyanide is reduced at the dropping mercury electrode in two steps with the following half wave-potentials in the different supporting electrolytes. $E_{\frac{1}{2}}$ —0.14; —.16 and-0.15V. for the first wave, and —0.53, —0.90 and —0.66 for the Second wave in potassium chloride, sodium chloride and lithium chloride respectively, Analysis of wave shows that wave one is reversible corresponding to one electron

transfer reaction (the reversibility was tested by Tomes method[12] and by plotting log (i/id-i) against E [13]. The number of electrons involved in the reduction was derived from the Ilkovic expression $n=I/605\ D^{1/2}$, where $I=id/Cm^{2/3}t^{1/6}$. The value of I, the diffusion current const, was found to vary with concentration, higher values being obtained at lower concentration. The value of the diffusion coefficient was calculated from the aquivalent conductance with the aid of the equation[14] $D=2.67\times10^{-7}\lambda/Z$ Taking$\lambda^{=160}$ mhos at infinite dilution and Z=3, $D=14.23\times10^{-6}$. Thus the velue of n comes out to be I/2.27; n=0.894.

Hence the reduction of potassium aqua pentacyanide can be assumed to be a one electron transfer reaction and the reaction may be represented as:

$$(Fe^{ii}(CN)_5H_20)^{-3}+e \rightarrow (Fe^{i}(CN)_5H_20)^{-4}$$

As for the second wave, the probable reduction at the d.m.e. may be into Fe (0):

$$(Fe^{i}(CN)_5H_20)^{-4}\pm e \rightarrow Fe(Hg)+H_20+5CN^{-}$$

Polarograms in different buffers give two waves in the pH range (2.0-11.0) studied. The first wave is reversible upto pH 5.0 after which both the wave become irreversible. The results are tabulated in the following tables;

TABLE 1.

E 1/2 and I values for the reduction of aqua pentacyanide in different buffers using Licl as the supporting electrolyte.

pH	Nature of wave		E 1/2		I
	Wave I.	Wave II.	Wave I.	Wave II.	
2.0	Reversible	Irreversible	—0.12	—1.02	3.02
3.0	,,	,,	—0.14	—1.0	2.01
3.4	,,	,,	—0.14	—0.98	1.99
4.0	,,	,,	—0.16	—0.96	1.976
4.6	,,	,,	—0.18	—0.94	1.94
5.0	,,	,,	—0.20	—0.90	1.92
7.0	Irreversible	,,	—0.16	—0.80	1.62
8.7	,,	,,	—0.16	—0.96	—
9.2	,,	,,	—0.16	—0.80	—

From the curve between pH and I it is seen that a sudden decrease in the value of I takes place beyond pH-5. This is also supported by the fact that the first wave becomes irreversible after this pH.

The irridation of potassium aqua pentacyanide by ultra violet light or an exposure to electric buln (500 watts) transforms the first wave (originally reversible) into an irreversible one. Such an effect is, however, not observed on exposing the solution to direct sunlight (4 hours). It means that the compound potassium aqua pentacyanide is light sensitive. The results on the E 1/2 values of ihe irridated product are summarised below.

TABLE II

E 1/2 valuess of light exposed samples of potassium aqua pentacyanide (0.005M) in 1M Licl.

Sample.	No. of wave.	E 1/2	
		Wave I	Wave II
Unexposed.	2	—0.16	—0 90
Exposed to U.V Light.	2	—0.24	—0.92
Exposed to light from elactric bulb.	2	—0.28	—0.92
Exposed to sunlight	2	—0.17	- 0.94

It is rather interesting to note that potassium ferrocyanide exposed to light from electric bulb (4 hours) gave two waves with E 1/2=0.16 and —0.90. The same values as for unexposed potassium aqua pentacyanide.

Further work is in progress.

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ALGAL FLORA OF DEHRA DUN-IV. ZYGNEMACEAE.

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This is the fourth communication in series on the algal flora of Dehra Dun (c.f. Khan, 1970, in press), dealing with 25 taxa of Zygnemaceae.

SYSTEMATIC ENUMERATION

Debarya costata Randhawa
Vegetative cells 6.5—9μ broad
Habitat—Free floating, Mohand; December 1970.

D. jogensis Iyengar
Vegetative cells 6.5—9$\mu \times$ 5.6—9μ; zygospores 31.9—40μ.
Habitat—In rock-pools, Claymen Town; November 1970.

Mougeotia genuflexa (Dillwyn) **Agardh**
Vegetative cells 33.9 $\times$ 114μ; zygospores 31.5—42μ.
Habitat—Rispana river; August 1968.

Zygnema stellinum (Vaucher) Agardh
Vegetative cells 23.0—49.7μ; zygospores 33.0—39μ.
Habitat—In rock-pools, Sahastradhara; January 1971.

Spirogyra colligata Hodgetts
Vegetative cells 42.9 $\times$ 112—134μ; Zygospores 29.7—52.8μ.
Habitat—In puddles, Raiwala; October 1970.

S. condensata (Vaucher) Kutz.
Vegetative cells 52.8 $\times$ 105.6μ; zygospores 33—34μ.
Habitat—Free floating, Dandalakhond; August 1968.

S. intorta Jao
Vegetative cells 29.7 $\times$ 125.4μ; zygospores 23.1 $\times$ 33.0μ.
Habitat—In stagnant water, Sahastradhara; December 1970.

S. singularies Nordstedt
Vegetative cells 33—36.3$\mu \times$ 59.4—82.5u; zygospores 29.7—33.0$\mu \times$ 42.9—52.8μ.
Habitat—In pools, Mohand; November 1970.

S. teodoresci Transeau
Vegetative cells 29.7 $\times$ 92.4μ; zygospores 23.1 $\times$ 42.9μ.
Habitat—Free floating, Rajpur; November 1970.

S. Varians (Hassall) Kutz.
Vegetative cells 42.9 $\times$ 92.44; zygospores 29.7 $\times$ 56.1μ.
Habitat—In streams, Sahastradhara; November 1970.

S. paradoxa Rao
Vegetative cells 52.8 × 99.0μ; zygospores 46.2 × 79.2μ.
Habitat—In rain water pools, Dakpathar; December 1970.

S. bichromatophora (Randhawa) Transeau
Vegetative cells 62.7 × 132μ; zygospores 56.1 × 75.9μ.
Habitat—In pond, Premnagar; December 1970

S. pulchrifigurata Jao
Vegetative cells 40.3 × 214.5μ; zygospores 49.5 × 56.1μ.
Habitat—Free floating, Rajpur; August 1970.

S. grossii Schmidle
Vegetative cells 56.1 × 158.4μ; zygospores 52.8 × 69.3μ.
Habitat—Rain water pool, Dakpathar; September 1970.

S. kundaensis Singh
Vegetative cells 105—115μ × 142—142—170μ; zygospores 75—80 × 109.8μ.
Habitat—In pond, way to Dakpathar; August 1968.

S. wabashensis Tiffany
Vegetative cells 49.5 × 211.2μ; zygospores 52.8 × 58.8μ.
Habitat—In ponds, Raiwala; November 1970.

S. crassoidea Transeau
Vegetative cells 46.2 × 105.6μ; zygospores 36.2 × 52.8μ.
Habitat—In streams, Mohand; August 1970.

S. pseudovarians Czurda
Vegetative cells 33.0 × 82.5μ; zygospores 29.7 × 46.2μ.
Habitat—In stagnant water, Mohand; July 1970.

S. fragilis Jao
Vegetative cells 26.4 × 132.0μ; zygospores 29.7 × 42.9μ.
Habitat—In slow moving water, Mohand; August 1970.

S. hungarica Langer
Vegetative cells 52.8 × 98.9μ; zygospores 59.4 × 66.0μ.
Habitat—In ponds, Dakpathar; August 1969.

S. esthonica (Skuja) Czurda
Vegetative cells 26.4 × 75.9μ; zygospores 33.0 × 46.2μ.
Habitat—In flowing water, Sahastradhara; September 1970.

S. texensis Taft
Vegetative cells 66.0 × 68.1μ; zygospores 72.6 × 66.0μ.
Habitat—In stagnant water, Rajpur; December 1970.

S. agnolensis Welwitsch

Vegetative cells 56.1 194.7μ; zygospores 52.8 85.8μ.

Habitat—In pond, Vikasanagar; October 1970.

Sirogonium pseudofloridanum (Prescott) Transeau

Vegetative cells 50—59μ 198.9μ; zygospores 61—70 119μ.

Habitat—In running water, Yamuna canal; August 1968.

Sirocladium kumaoensis Randhawa

Vegetative cells 42—62 115—210μ; zygospores 42.9 69.8μ.

Habitat—On moist rocks, Sahanshahi Ashrama; October 1970.

SUMMARY & CONCLUSION

The present communication deals with 25 species belonging to 6 genera of Zygnemaceae.

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GIBBERELLIC ACID INDUCED CHANGES IN LEAF SHAPE AND SIZE IN COLOCASIA ESCULENTA (Boda, Desi Variety).

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C. esculenta a native of South East Asia is an important vegetable crop. There are 1000 horticultural varieties of the plant. All the parts of the plant except root are edible. The tuber is richer in carbohydrate and proteins and one and a half times more nutritious than potato. It is reported to be more easily digested than other starchy foods. Steamed tubers containing 30% starch and 3% sugars form a high energy food.

In India the usual planting period of the crop is February to July. The crop has a long harvesting period ranging from four to nine months.

Thirty-two bubers each of *C. esculenta* (Boda, Des.) were soaked in water and in the following solutions of gibberallic acid in water for 48 hours.

1. 100 ppm.
2. 200 ppm.
3. 500 ppm.

The soaked tubers were sown in pots filled with sand, cowdung manure and soil in the ratio of 1:1:1.

In all the three GA treatments the leaves differed in shape and size from the control. The leaf blade in the treatments was more elongated and in some cases simulated a betel leaf in shape. The colour of the leaves was lighter green than that of control. The groove on the broad-side of the leaf was diminished in depth ih several cases and in some cases it was almost completely obliterated. The length of the petiole of the first leaf in GA 500ppm treatment reached upto 14cms. as against 6 cms. of control. The opening of the first leaf in GA 100ppm and GA 200ppm treatment was delayed. The size of the plants in the initial stages, increased in GA 500ppm treatment and decreased in the other two treatment as given in the table.

It is evident from the above table that GA can modify a number of characters in *C. esculenta*. However, the leaf character has not been modified to the extent it has been modified in the Pahari variety where the leaf blade ceases to form or is imperfectly formed assuming different shapes. The differentiation of buds on mother tubers is hastened by the GA treatments at 200 ppm. and 500 ppm concentration. GA 100 ppm was not found so effective in this regard.

ACKNOWLEDGMENT

The author wishes to record his sincere thanks to Dr. B. D. Baijal and Dr. S. K. Sinha of Agra College, Agra and I. A. R. I., New Delhi respectively for their keen interest and counsel during the period of studies.

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TABLE I SHOWING THE RESPONSE OF C. ESCULENTA TO GA TREATMENTS

TABLE I SHOWING THE RESPONSE OF C. ESCULENTA TO GA TREATMENTS

1	2	3			4		5	6	7
Treatment	Date of sowing	Number of plants in which Ist leaf has opened.			Height of the plant in cms. (based on petiole lenght)		Angle that the midrib formed with the margin at the apex of the leaf.	No. and size of buds on mother tuber as on 11.5.71	Size of the leaf-blades as on 11. 5. 71 length breadth (c.m.)
		11.4.71	18.4.71	24.4.71	11.4.71	11.5.71			
Control	22.3.71	6	21	26	4-6	12-20	55°-70°	2, upto 4 mm. long.	14×12.5, 12.5×12, 11×10. 5, 15.5×12.5.
GA 100	22.3.71	×	2	10	×	10-18	38°-40°	4, upto 15mm. long.	9×5, 10. 5×7. 5, 10×6. 5.
GA 200	22.3.71	×	4	10	×	12-18	20°-30°	6, upto 18mm. long.	10×4, 11×5, 12×6.
GA 500	22.3.71	4	9	18	12-14	23-26	38°-40°	6, upto 60mm. long.	12×9, 13×7, 15×9.5, 11×7.

AN ARTIFICIAL KEY TO CULTIVATED SPECIES OF EUCALYPTUS IN INDIA

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ABSTRACT

The paper deals with an artificial key to commonly cultivated species of *Eucalyptus* in Indian gardens, parks, plantations, arboreta and silvata. It covers 95 species of eucalypts that have been introduced into India for timber, pulp, firewood, oil, shade and shelter, afforestation and for ornamental purposes. The key is based mainly on broad morphological characters drawn from various parts such as leaves, buds, inflorescence, anthers, fruits, seeds, operculum and bark. It is intended to be of use in the field and herbarium. The illustrations of leaves, operculum and fruits are provided to facilitate their identification.

INTRODUCTION

The genus *Eucalyptus* L' He′rit. occurs naturally in Australia and Malesian region, but has attained world-wide distribution by introduction and cultivation (Anon., 1955; Bentham & Mueller, 1866; Maiden, 1903-1931; Bailey, 1953; Kelly, 1949; Black, 1952). The rapid growth, unique variety, adaptability, ease of cultivation and usefulness of the eucalypts have made them as the world's most celebrated exotic outside their natural range. Many countries like Argentina, Brazil, China, Congo, Ethiopia, Guatemala, Uruguay and the U.S.S.R. have shown a growing interest in the essential oil-yielding species. Other countries including Iran, Iraq, Israel and Ethiopia are more interested in the quick-growing species which will furnish building and structural timbers, firewood and pulp for paper-making and in rayon manufacture. In India, Ceylon, Hawaii, etc. eucalypts are useful for afforestation and are common in cultivation as ornamental or avenue trees, and as wind-breaks and shade trees for the protection of crops. Some species such as those belonging to 'Box' group and 'Ironbarks' are among the best honey plants of the world (Penfold & Willis, 1961). Apart from its utilitarian role, the eucalypts give a characteristic view to our parks and gardens by their spectacular and brilliant flowers, brightly coloured buds and opercula, branching patterns, attractive foliage, and colourful and decorative barks (Kaul, 1965).

The genus was introduced into India as early as 1843 when Captain Cook planted a few trees of E. *globulus* Labill. (Blue Gum) in the Nilgiri Hills. Since then, 36 species of eucalypts growing in Sim's Park,Coonoor,on the Nilgiris in South India have been described (Narayana Menon & Kuppuswamy, 1957). In recent years, eucalypts have gained such an importance that most of the States in India have launched extensive plantation programs (Parker, 1925; Pallithanam, 1957; Kaul & Nambiar, 1966; Kaul, 1967; Matthew, 1969). However, the eucalypts have always posed taxonomic problems concerning their correct identification, especially to many field workers, e. g. foresters, ecologists, planters and surveyors. This is mainly due to wide variation and marked similarity among species, many of which often grow in close association. Some of the features, such as bark types, are

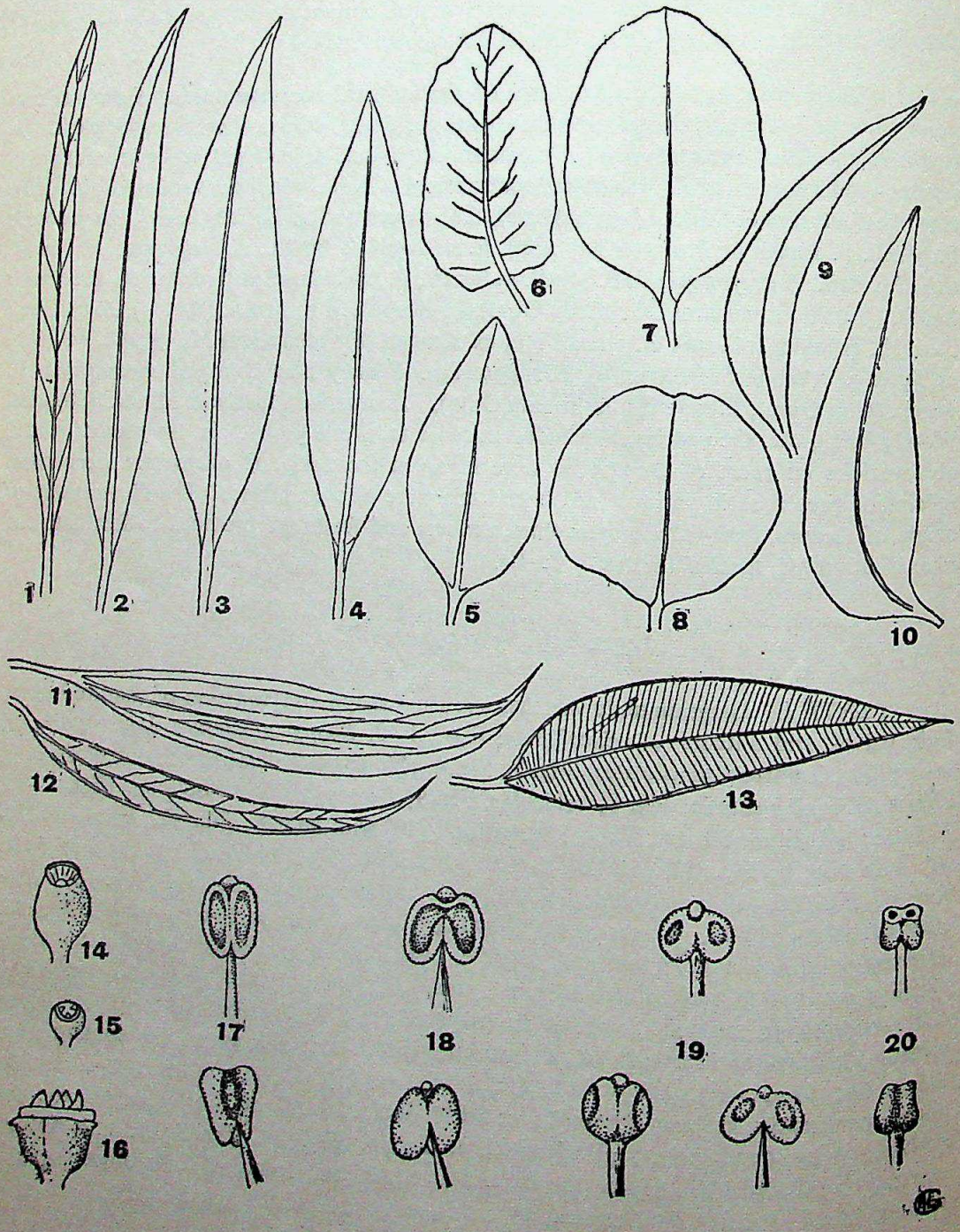
similar in a number of species, whilst features like leaf shape and size show considerable variation even on single trees. In a number of cases, old trees since their planting are known under wrong names. This mistake is even carried further when seeds are supplied with wrong labels. Thus, complete botanical material is required for identification work, together with detailed notes on the general habit, juvenile and mature leaves, size of vegetative, floral and fruit parts, and the characters of bark both at the base of trunk and on the ultimate branches (Blakely, 1934; Hall & Johnston, 1965).

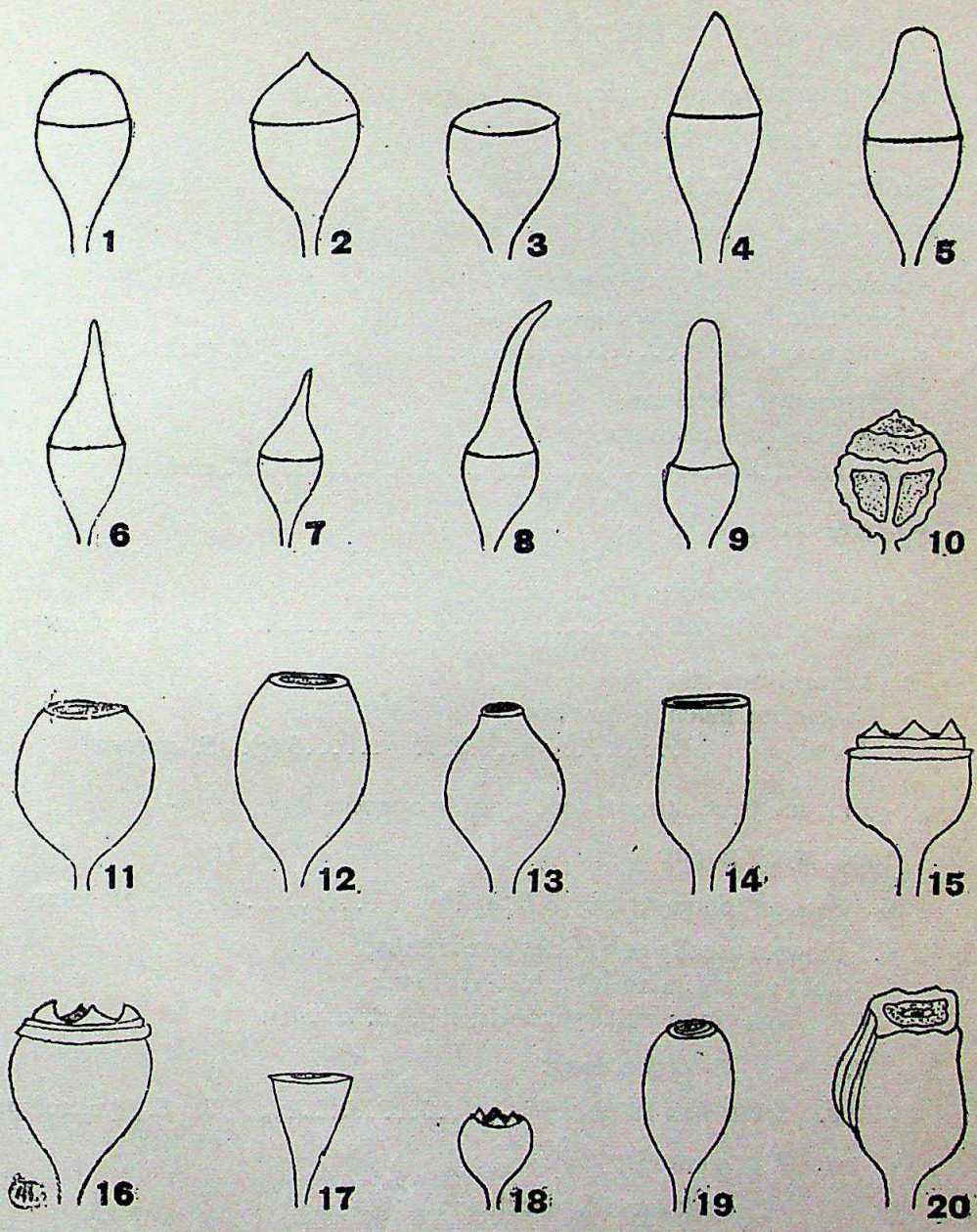
The present key is based on broad morphological characters drawn from various parts such as leaves, buds, inflorescence, anthers, fruits, seeds, opercula and bark. It covers 95 species of eucalypts that are commonly cultivated in gardens, parks, arboreta and silvata, and have successfully grown and acclimatized in India. In the case of highly variable taxa like *E. cinerea* F. Muell. (Argyle Apple), *E. haemastoma* Sm. (Scribby Gum), *E. tessellaris* F. Muell. (Carbeen or Moreton Bay Ash), *E. siderophloia* Benth., *E. staigeriana* F. Muell. ex F. M. Bail., *E. drepanophylla* F. Muell. ex Benth., *E. paniculata* Sm. (Ironbarks), *E. cornuta* Labill. (Yate), *E. punctata* DC. (Grey Gum), *E. elaeophora* F. Muell. (Bundy), *E. maidenii* F.Muell. (Maiden's Gum), *E. grandis* Hill ex Maiden (Flooded Gum), *E. eugenioides* Sieb. ex Spreng. (White Stringybarks), *E. saligna* Sm. (Sydney Blue Gum), E. *cosmophylla* F. Muell. (Cup Gum), *E. rudis* Endl. (Swamp Gum), *E. macarthurii* Deane & Maiden (Camden Woolly butt), etc. the species is included in more than one group. In the present study, observations on most of the species were made in the field and arboreta. Herbarium specimens preserved in various Indian herbaria were also examined. The illustrations of shape of leaves, fruit-valves, operculum, anthers and fruits are provided to facilitate the identification of species (Plates I & II).

Legends of figures (PLATE I)

PLATE I. Diagrammatic sketches showing shape and venation of mature leaves, fruit valves and anthers of *Eucalyptus*: Figs. 1-10, *Shape of mature leaves :* Fig. 1, linear; Fig. 2, narrow-lanceolate; Fig. 3, Fig. 4, oblong-lanceolate; Fig. 5, ovate; Fig. 6, oblong; Fig. 7, elliptic; Fig. 8, orbicular; Fig. 9, falcate; Fig. 10, oblique. Figs. 11-13, *Venation of mature leaves :* Fig. 11, venation $\angle 20°$ with midrib; Fig. 12, venation 25°-60° with midrib; Fig. 13, venation $>60°$ with midrib. Figs. 14-16, *Illustrations of fruits valves :* Fig. 14, valves enclosed; Fig. 15, valves more or less rim level; Fig. 16, valves exserted. Figs. 17-20, Anther-types showing their shape and dehiscence : Fig. 17, *Macrantherae*, i. e. anthers versatile, cordate, oval, oblong or orbicular; distinct loculi opening into two lobes of auricular shape; gland fairly large, situated in the upper half of the commissure, sometimes visible from the front; Fig. 18, *Renantherae*, i. e. anthers versatile, kidney- or heart-shaped, almost flat; loculi divergent, sometimes coming together at tip; gland very small or indistinct at the tip. Fig. 19, *Porantherae*, i. e. anthers adnate or versatile, globular or reniform; fairly distinct loculi opening towards the top or laterally by round pores; gland small at the tip. Fig. 20, *Terminales*, i. e. anthers adnate or placed obliquely on the filament, cuneiform, rounded or alomost square; distinct loculi opening by terminal, ovai slits or round pores: gland absent.

PLATE I





Legends of figures (PLATE II)

PLATE II. Diagrammatic sketches showing shape of buds, operculum and fruits of *Eucalyptus*.

Figs. 1-10, *Buds showing shape of operculum :* Fig. 1, hemispherical; Fig. 2, peaked-hemispherical; Fig. 3, flattened-hemispherical; Fig. 4, conical; Fig. 5, obtuse-conical; Fig. 6, acute-conical; Fig. 7, rostrate; Fig. 8, horned or elongated; Fig. 9, cylindrical; Fig. 10, boss-shaped (e. g. *E. globulus*). Figs. 11-20, *Shape of fruits:* Fig. 11, globular; Fig. 12, ovoid; Fig. 13, urceolate; Fig. 14, cylindrical; Fig. 15, hemispherical; Fig. 16, broad conical; Fig. 17, conical; Fig. 18, turbinate; Fig. 19, pyriform; Fig. 20, quadrangular.

EUCALYPTUS L' He'rit.

1. Leaves on mature trees opposite:
   2. Fruit-valves deeply enclosed:
      3. Shrubs; leaves *Ca.* 1.5 cm. long.....1. *E. kruseana*

         Trees; leaves 4-9 cm. long:

      4. Bark rough, deeply furrowed, persistent; leaves cordate—ovate to orbicular.....2. *E. melanophloia*

      4. Bark smooth, deciduous; leaves cordate-lanceolate, connate .....3. *E. risdonii*

   2. Fruit-valves exserted:

      5. Leaves orbicular to ovate, nearly as long as broad .....4. *E. pulverulenta*

      5. Leaves ovate-lanceolate to lanceolate, much longer than broad .....5 (c). *E. cinerea*

1. Leaves on mature trees alternate (occasionally opposite (in *E. ptychocarpa*):

   6. Flowers solitary (rarely 2-3), axillary ..... 6. *E. globulus*

   6. Flowers usually in panicles or corymbs, not in simple umbels (sometimes lower ones in in axillary umbels, e. g. *E. albens*):

      7. Fruits 30-50 mm. long:

         8. Fruits 9 to 12-ribbed ..... 7. *E. ptychocarpa*

         8. Fruits not ribbed:

            9. Bark smooth, deciduous except at the base of the trunk ..... 8 (b). *E. terminalis*

            9. Bark rough, persistent to the branches:

               10. Seeds winged..... 9. *E. ficifolia*

               10. Seeds not winged..... 10. *E. calophylla*

      7. Fruits 6-25mm. long:

         11. Operculum conical or acutely conical:

12. Umbels in the panicle 5 to 12-flowered (sometimes less in *E. albens*):

13. Buds pedicellate:

14. Bark rough, persistent at least on the trunk:

15. Fruits 16-25 × 12-20mm.... 11. *E. intermedia*

15. Fruits 5-10 × 4-7mm.:

16. Anthers versatile, opening by parallel slits ..... 12. *E. intertexta*

16. Anthers adnate, opening by pores or slits:

17. Peduncle up to 9 mm. long; operculum usually somewhat shorter than the receptacle .....13 (d). *E. melliodora*

17. Peduncle up to 15 mm. long; operculum about as long as the receptacle .....14 (b). *E. hemiphloia*

14. Bark smooth, deciduous; buds *ca* 6 mm. long .....15(d). *E. haemastoma*

13. Buds sessile or subsessile; bark subfibrous, persistent on trunk, smooth elsewhere .....16. *E. albens*

12. Umbels in the panicle 2 to 3 (4)- flowered ..... 17. *E. maculata*

11. Operculum flattened to hemispherical or peaked-hemispherical:

18. Buds and fruits sessile (or subsessile in *E. torelliana*):

19. Branchlets hispid; leaves not falcate, intramarginal vein absent .... 18. *E. torelliana*

19. Branchlets not hispid; leaves falcate, intramarginal vein present .... 19. *E. eximia*

18. Buds and fruits pedicellate:

20. Petiole 1mm. long; buds 3-5 mm. in diam. .... 20 (b). *E. tessellaris*

20. Petiole longer; buds more than 5 mm. in diam. :

21. Fruits over 1.5 cm. long:

22. Bark rough; fruits up to 20×15mm. ..... 21. *E. gummifera* (syn.*E. corymbosa*)

22. Bark smooth; fruits up to 40×23mm. .... 8 (a). *E. terminalis*

21. Fruits up to 1 cm. long:

23. Bark rough on trunk; fruits 5-7 mm. in diam. .....13(c). *E. melliodora*

23. Bark smooth throughout; fruits 9-10 mm. in diam.:

24. Umbels in the panicle 3 to 5-flowered ..... 22. *E. citriodora*

24. Umbels in the panicle 6 to 12-flowered 15(c). *E. haemastoma*

7. Fruits up to 6 mm. long:

25. Leaves orbicular to ovate or broadly lanceolate, often nearly as long as or up to 3 times as long as broad:

26. Anthers opening by terminal pores .....23. *E. polyanthemos*

26. Anthers opening widely ..... 24. *E. populnea*

25. Leaves ovate to oblong-elongate or lanceolate, much longer than broad:

27. Bark smooth at least on upper trunk (fibrous persistent in the lower part of the trunk in *E. hemiphloia*):

28. Valves exserted; bark deciduous ..... 25. *E. deglupta* (syn. *E. naudiniana*)

28. Valves enclosed; bark persistent in the lower part of the trunk ..... 14 (a). *E. hemiphloia*

27. Bark rough on trunk (sometimes smooth in *E. melliodora*):

29. Operculum much longer than the receptacle .....26(b). *E. siderophloia*

29. Operculum about as long as the receptacle(sometimes slightly longer than the receptacle in *E. drepanophylla*):

30. Operculum acutely conical:

31. Leaves lemon-scented; small to medium-sized trees .....27(b). *E. staigeriana*

31. Leaves not lemon-scented; large trees:

32. Anthers opening longitudinally and widely .....28(f). *E. drepanophylla*

32. Anthers opening by terminal pores .....29(b). *E. paniculata*

30. Opereulum usually hemispherical :

33. Peduncle angular.....30. *E. microtheca*

33. Peduncle cylindrical.....28(e). *E. drepanophylla*

29. Operculum shorter than the receptacle:

34. Bark rough on the trunk, smooth on the branches:

35. Buds 7-8 × 5-6 mm; fruits 5-7 × 5-7 mm..... 13(b). *E. melliodora*

35. Buds 5 × 3-4 mm. fruits *ca* 4 × 5mm..... 31. *E. largiflorens*) (*syn. E. bicolor*

34. Bark rough and persistent to the branches:

36. Anthers opening by small terminal pores; buds *ca* 10mm. long.....29(a). *E. paniculata*

36. Anthers opening laterally in full length; buds 4-6mm. long..... 32. *E. crebra*

6. Flowers in simple umbels (sometimes apparently paniculate owing to leaf-shedding):

37. Pedicels and/or peduncles flattened :

38. Fruits-valves projecting well beyond calyx-rim :

39. Valves connivent into a cone; operculum 2.5-3.7 cm. long..... 33 (b). *E. cornuta*

39. Valves distinct; operculum 1.8 cm. or less:

40. Operculum longer than the receptacle;

41. Trees; operculum not ribbed :

42. Bark smooth, deciduous .....34 (c). *E. punctata*

42. Bark rough, persistent:

43. Fruits 10-14 mm. in diam. ..... 35 (b). *E. kirtoniana*

43. Fruits 5-8 mm. in diam. .....36. *E. resinifera*

41. Shrubs; operculum ribbed .....37 (b). *E. pachyphylla*

40. Operculum shorter than or as long as the receptacle:

44. Buds 4-5 mm. long..... 38 (b). *E. propinqua*

44. Buds more than 8 mm. long:

45. Bark rough, persistent to the small branches..... 39 (b). *E. elaeophora*

45. Bark deciduous, smooth:

46. Operculum verrucose .....40 (b). *E. maidenii*

46. Operculum not verrucose:

47. Buds glaucous .....41 (b). *E. grandis*

47. Buds not glaucous:

48. Buds sessile or nearly so .....42 (g). *E. saligna*

48. Buds with long pedicels .....34 (b). *E. punctata*

38. Fruit-valves included or scarcely exserted beyond the

calyx - rim (exserted but closely incurved in *E. megacarpa* and *E. gomphocephala*):

49. Fruits less than 1.25 cm. in diam.:

50. Buds sessile (seometimes very shortly pedicellate in *E. eugenioides*):

51. Operculum as long as the receptacle or longer:

52. Buds 6-10 mm. long:

53. Umbels up to 9-flowered:

54. Fruits up to 10mm. in diam. ..... 5 (b). *E. cinerea*

54. Fruits up to 6 mm. in diam. ....42 (f). *E saligna*

53. Umbels up to 20-flowered .....43 (f). *E. eugenioides*

52. Buds *ca* 15 mm. long .....40 (a). *E. maidenii*

52. Buds 20-25mm. long:

55. Trees; buds glaucous .....44 (b). *E. stricklandii*

55. Shrubs; buds not glaucous ....45. *E. grossa*

51. Operculum shorter than the receptacle:

56. Bark smooth on the branches, rough on trunk; leaves glaucous ..... 5 (a). *E cinerea*

56. Bark rough or fibrous throughout; leaves not glaucous:

57. Operculum conical:

58. Leaves oblique at base ....46. *E. capitellata*

58. Leaves not oblique at base .... 39 (a). *E. elaeophora*

57. Operculum hemispherical ....47. *E. botryoides*

50. Buds pedicellate (sometimes subsessile in *E. diversifolia*):

59. Operculum longer than the receptacle:

60. Fruits 5-6mm. long ..... 48 (b). *E. acmenioides* (syn. *E. triantha*)

60. Fruits more than 8 mm. long:

61. Usually shrubs:

62. Buds more than thrice as long as broad; fruits *ca* 7mm. in diam ....49. *E. redunca*

62. Buds *ca* twice as long as broad; fruits 10-15mm. in diam.....50 (b). *E. diversifolia*

61. Trees:

63. Peduncle 2-3 cm. long 51 (b). *E. robusta*

63. Peduncle less than 2 cm. long:

64. Anthers reniform ....52. *E. pilularis*

64. Anthers obcordate .....34 (a). *E. punctata*

59. Operculum as long as or shorter than the receptacle:

65. Fruits less than 6 mm. long :

66. Buds about as long as broad :

67. Leaves 10-18mm. broad:

68. Anthers opening by lateral slits; bark smooth at base.....53. *E. rossii*

68. Anthers opening by lateral pores; bark dark, rough at base .....54 (b). *E. gracilis*

67. Leaves 4-5mm. broad .....55. *E. linearis*

66. Buds twice as long as broad (or less in *E. acmenioides* but always longer than broad):

69. Fruits sessile or nearly so :

70. Bark furrowed, persistent .....43 (e). *E. eugenioides*

70. Bark smooth, deciduous .....42 (e). *E. saligna*

69. Fruits pedicellate:

71. Anthers opening by pores .....27 (a). *E. staigeriana*

71. Anthers opening by broad lobes .....42 (d). *E. saligna*

71. Anthers opening by slits:

72. Operculum hemispherical .....56. *E. foecunda*

72. Operculum conical or rostrate .....48 (a). *E. acmenioides* (syn. *E. triantha*)

65. Fruits more than 7 mm. long:

73. Operculum less than half as long as the receptacle :

74. Shrubs, 1-3 m. high, many -stemmed; leaves narrow, 7-10mm. broad.....57. *E. stricta*

74. Trees; leaves broader :

75. Bark smooth .....15 (*b*). *E. haemastoma*

75. Bark deeply furrowed:

76. Peduncle up to 20 mm. long; lateral veins of leaves at an angle of 45-65° with midrib ..... 58. *E. microcorys*

76. Peduncle up to 14 mm. long; lateral veins of leaves at an angle of 15-35° with midrib .....59 (c). *E. sieberiana*

73. Operculum at least half as long as the receptacle:

77. Operculum broader at the base than the receptacle and coarsely ribbed or corrugated .....60 (b). *E. torquata*

77. Operculum neither broader than the receptacle, nor ribbed or corrugated:

78. Leaves lanceolate-falcate:

79. Fruits 5-8mm. in diam.; peduncle up to 25 mm. long; lateral veins of leaves at an angle of 20° with midrib or less and often almost parallel to the midrib .....61 (b). *E. pauciflora*

79. Fruits 9-10 mm. in diam.; lateral veins of leaves at an angle of 15-40° with midrib .....15 (a). *E. haemastoma*

78. Leaves ovate-lanceolate, not falcate:

80. Fruits more than 10 mm. long:

81. Bark smooth; operculum conical .....62. *E. virgata*

81. Bark rough, persistent; operculum rostrate ..... 51 (a). *E. robusta*

80. Fruits less than 10 mm. long:

82. Mature leaves ovate to broadly lanceolate-ovate, up to 10 cm. broad ..... 63. *E. alba*

82. Mature leaves lanceolate to narrowly lanceolate, up to 3.5 cm. broad:

83. Fruits sessile or very shortly pedicellate; buds 6-8 mm. long ..... 43 (d). *E. eugenioides*

83. Fruits pedicellate; buds *ca* 10 mm. long ..... 41 (a). *E. grandis*

83. Fruits shortly pedicellate or sessile; buds *ca* 14 mm. long ..... 64. *E. goniocalyx*

49. Fruits more than 1.25 cm. in diam.:

84. Operculum not or scarcely broader than the receptacle ..... 65 (c). *E. cosmophylla*

84. Operculum much broader than the receptacle ..... 66. *E. gomphocephala*

37. Pedicels and/or peduncles cylindrical or angular but not flattened :

85. Fruits sessile or subsessile:

86. Fruit-valves exserted:

87. Leaves often emarginate ..... 67 (b). *E. ovata*

87. Leaves not emarginate:

88. Umbels generally 3-flowered:

89. Trees; buds *ca* 5 mm. in diam.:

90. Juvenile leaves orbicular ..... 68. *E. rubida*

90. Juvenile leaves lanceolate, elongated ..... 69. *E. viminalis*

89. Shrubs; buds *ca* 20 mm. in diam. ..... 37 (*a*). *E. pachyphylla*

88. Umbels usually more than 3-flowered:

91. Leaves less than 1 cm. in breadth:

92. Operculum shorter than the receptacle ..... 70 (b). *E. amygdalina*

92. Operculum as long as or longer than the receptacle:

93. Buds about 10 mm. long:

94. Peduncle 6-10 mm. long; fruits less than 10 mm. in diam. .....71. *E. exserta*

94. Peduncle 10-15 mm. long; fruits over 10 mm. in diam .....72 (c). *E. rudis*

93. Buds *ca* 5 mm. long .....73 (c). *E macarthurii*

91. Leaves usually more than 1 cm. in breadth:

95. Peduncle 25-40 mm. long .....33 (a). *E. cornuta*

95. Peduncle 3-15 mm. long:

96. Bark smooth throughout:

97. Operculum shorter than the receptacle .....65 (b). *E. cosmophylla*

97. Operculum as long as or longer than the receptacle .....38 (a). *E. propinqua*

96. Bark rough, persistent at least on the lower portion of the trunk:

98. Leaves undulate:

99. Peduncle up to 6 mm. long; anthers versatile, opening by parallel slits .....74. *E. bridgesiana* (syn. *E. stuartiana*)

99. Peduncle up to 12 mm. long; anthers scarcely adnate, with distinct cells opening longitudinally and widely .....28 (d). *E. drepanophylla*

98. Leaves not undulate:

100. Buds *ca* 5 mm. long .....73 (b). *E. macarthurii*

100. Buds 8-15 mm. long:

101. Fruits 10-12 mm. in diam. .....72 (b). *E. rudis*

101. Fruits up to 7 mm. in diam. :

102. Bark rough, persistent to the branches; anthers adnate (scarcely adnate in *E. drepanophylla :*

103. Anthers subglobular to obovate; buds 7-10 mm. long; fruits 5-7 x 4-6 mm .....28 (c). *E. drepanophylla*

103. Anthers cordate-reniform to oblong; buds 10-15 mm. long; fruits 6-9 × 7-8 mm. .....26 (a). *E. siderophloia*

102. Bark smooth, deciduous on the branches, rough and persistent on the trunk; tanthers versaile:

104. Operculum longer than the receptacle .....75. *E. dealbata*

104. Operculum as long as or shorter than the receptacle .....42 (c). *E. saligna*

86. Fruit-valves enclosed or hardly exceeding the rim:

105. Operculum longer than the receptacle:

106. Fruits 10-15 mm. in diam..... 50 (a). *E. diversifolia*

106. Fruits 4-7 mm. in diam.:

107. Anthers subglobose to obovate .....28(b). *E. drepanophylla*

107. Anthers reniform .....43 (c). *E. eugenioides*

105. Operculum as long as or shorter than the receptacle :

108. Leaves up to 2 cm. broad:

109. Anthers obvate, obovate-oblong, globular or long and narrow:

110. Buds about as long as broad .....73 (a). *E. macarthurii*

110. Buds about twice as long as broad:

111. Bark rough, deeply furrowed, persistent throughout .....28 (a). *E. drepanophylla*

111. Bark smooth, deciduous except at the base of the trunk:
112. Fruits 8-12 mm. long; leaves usually up to 1 cm. broad .....20 (a). *E. tessellaris*
112. Fruits 5-6 mm. long; leaves usually 1.5-3 cm. broad.....42 (b). *E. saligna*

109. Anthers reniform:
113. Bark smooth, deciduous except at the base of the trunk .....54 (a). *E. gracilis*
113. Bark fibrous, persistent to the branches:
114. Bark furrowed .....43 (b). *E. eugenioides*
114. Bark not furrowed:
115. Leaves usually more than 1 cm. broad; petiole 1-1.75 cm. long; fruits up to 7×7 mm .. ....76 (b). *E. radiata*
115. Leaves 0.7- 1 cm. broad; petiole much shorter; fruits up to 5×5 mm. .....70 (a). *E. amygdalina*

108. Leaves more than 2 cm. broad :
116. Leaves oblique at the base:
117. Bark deeply furrowed, persistent throughout ....77. *E. obliqua*
117. Bark smooth throughout except at the base of the trunk:
118. Fruits 5-7 mm. in diam.....78 (b). *E. regnans*
118. Fruits 12-20 mm. in diam.. .. ..65 (a). *E. cosmophylla*

116. Leaves not oblique at the base:
119. Buds 15-21 mm. long:
120. Fruits 11-15 x 11-12 mm. :
121. Buds conical to apiculate-hemispherical, up to 18 mm. long ....79. *E. diversicolor*
121. Buds cylindroid, angular or costate, *ca* 21 mm. long .....44 (a). *E. stricklandii*
120. Fruits 30-70 x 20-50 mm. .....80. *E. miniata*

119. Buds up to 10 mm. long :
122. Bark fibrous, persistent to the branches:

123. Bark longitudinally furrowed; fruits 5-7 mm. long ....43 (a). *E. eugenioides*

123. Bark closely fibrous, not furrowed; fruits 4-5 mm. long .. ..76 (a). *E. radiata*

122. Bark smooth, deciduous except at the base of the trunk:

124. Anthers reniform; veins less than an angle of 20° with midrib:

125. Leaves up to 4 cm. broad; anthers opening by broad confluent cells .....61 (a). *E. pauciflora*

125. Leaves narrower, usually up to 2.5 cm. broad; anthers opening by divergent slits .....78 (a). *E. regnans*

124. Anthers versatile, cells obcordate, ovoid or long and narrow; veins usually over an angle of 20° with midrib:

126. Fruits 4-8 × 4-7 mm. :

127. Leaves lanceolate to ovate, often emarginate; veins at an angle of 20-45° with midrib .....67 (a). *E. ovata*

127. Leaves lanceolate, never emarginate; veins at an angle of 40-60° with midrib ....42 (a). *E. saligna*

126. Fruit 10-15 × 5-10 mm .... 81. *E. cladocalyx*

85. Fruits clearly pedicellate in the umbels:

128. Fruit-valves exserted (valves sometimes falling of in *E. oleosa*) :

129. Fruits 4-6 mm. in diam.:

130. Operculum rostrate ....82. *E. camaldulensis*

130. Operculum hemispherical or conical:

131. Anthers obovate to obcordate; umbels 3 to 7-flowered :

132. Bark on main trunk smooth ....83. *E. maculosa*

132. Bark on main trunk rough .....84. *E. nova-anglica*

128.

131. Anthers broadly reniform or oblong-reniform; umbels 5 to 14-flowered :

133. Trees; bark smooth, deciduous.... .....85. *E. salmonophloia*

133. Shrubs; bark rough at least at the base of trunk .....86. *E. oleosa*

129. Fruits 8-14 mm. in diam.:

134. Anthers reniform.. ....87. *E. macrorhyncha*

134. Anthers oblong, ovate or obovate:

135. Buds 5-9 mm. in diam.; fruits 10-12 mm. in diam.:

136. Leaves falcate, not glaucous; peduncle up to 15 mm. long .. ..72 (a). *E. rudis*

136 Leaves not falcate, glaucous; peduncle up to 22 mm. long .. ..35 (a). *E. kirtoniana* (syn. *E.patentinervis*)

135. Buds 3.5-6 mm. in diam.; fruits usually up to 8 mm. in diam..... .....88. *E. tereticornis*

128. Fruit-valves enclosed:

137. Umbels 2 to 3-flowered :

138. Buds 6-8 mm. long; peduncle 3-8 mm. long.....89. *E. gunnii*

138. Buds 10-30 mm. long; peduncle 10-30 mm. long:

139. Buds *ca* 10 mm. long; bark mottled, white and blue, smooth and deciduous except at the base of the trunk .....90 (b). *E. leucoxylon*

139. Buds up to 15 mm. long; bark black, furrowed.... ..... 91(b). *E. sideroxylon*

139. Buds up to 30 mm. long; bark grey, thick, fibrous or subfibrous .. ..92. *E. longifolia*

137. Umbels 3 to 15-flowered :

140. Peduncle 10-30 mm. long (sometimes less in *E. sieberiana*) :

141. Anthers adnate or subversatile, reniform :

142. Peduncle 10-15 mm. long :

143. Bark deeply furrowed; buds 5-7 mm. long .....59 (b). *E. sieberiana*

143. Bark not deeply furrowed; buds 12-15 mm. long .. ..93. *E. ochrophloia*

142. Peduncle 20-30 mm. long .....94. *E. marginata*

141. Anthers adnate, erect or oblique on the filaments, cuneate-truncate:

144. Bark smooth and deciduous except at the base of the trunk .....90 (a). *E. leucoxylon*

144. Bark rough, furrowed, persistent .. .. 91 (a). *E. sideroxylon*

141. Anthers versatile, obovate, emarginate.....60 (a). *E. torquata*

140. Peduncle 6-10 mm. long :

145. Bark deeply furrowed .. ..59 (a). *E. sieberiana*

145. Bark not deeply furrowed :

146. Anthers oblique on the filaments, cuneate, truncate .. ..13 (a). *E. melliodora*

146. Anthers reniform.....95. *E. piperita*

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DIGESTIVE CARBOHYDRASES OF SOME TELEOST FISHES

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ABSTRACT

The activity of amylase and sucrase in *Clarias batrachus*, *Ophicephaulus punctatus* and *Cirrhinus reba* has been studied. These enzymes act optimally at a *p*H between 5.6 and 6.4 in the different portions of the alimentary canal. In stomach or intestinal bulb, they act at a slightly acidic *p*H. The strength of the carbohydrases is more in the pancreas, hepatopancreas and intestine than in the rest of the portions. In general, the hepatopancreas is the main seat of production of these enzymes. The enzyme equipment of the fishes is adapted to the food and feeding habits. In *Cirrhinus reba*, which is predominently an herbivorous species, the concentration of the carbohydrases is higher than that in the carnivorous fishes.

INTRODUCTION

The food and feeding habits of fishes are correlated with the morphohistology of the alimentary canal and the enzemes secreted by it. According to Vonk (1941) the difference between the herbivorous and carnivorous fishes is less marked for the proteases than for the carbohydrases. In order to study, the source and the optimum *p*H for the carbohydrases and how far the enzyme equipment is adapted to the food of the fishes, the present work has been undertaken.

Out of the fishes studied, *Clarias batrachus* (Linn.) and *Ophicephalus punctatus* (Bloch) are carnivorous, while *Cirrhinus reba* (Hamilton) is predominently an herbivorous form. Along with the carnivorous diet, a little vegetable matter such as algal filaments may also be consumed by the two carnivorous fishes.

MATERIAL AND METHODS

A large number of living specimens of these fishes were collected from the local fresh water resources. Living animals were dissected and the different parts of the gut together with the associated glands were ground in a little thymol and a few drops of glycerine into an uniform emulsion. The emulsion was centrifuged, filtered and diluted to a final concentration of 10% (W/V) with 50% glycerine. Toluene was used as a preservative.

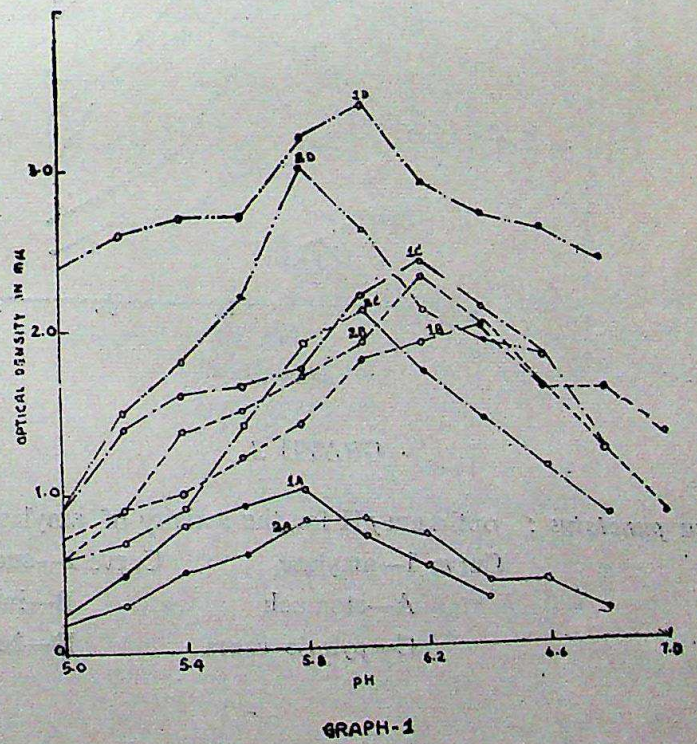
Estimation of enzyme activity

The activity of the carbohydrases was determined by estimating quantitavely the reducing sugars formed due to the hydrolysis of the carbohydrates. The colorimetric micro method of Nelson (1944) and Somogyi (1945) for blood glucose determination was adopted.

0.1 ml. of 1% soluble starch solution or 0.1 ml. of 1% sucrose solution, as the case, may be, were pre-incubated with 0.15 ml. of phosphate buffer of different *p*H (0.5 M, with a difference of 0.2) at 37°C and 0.1 ml. of the enzyme extract from the different parts of the alimentary canal was added. The incubated mixtures were boiled to stop any further activity after an incubation period of 3 hours. Triplicate samples of 0.1 ml. were withdrawn from each tube and diluted to 1.0 ml. with distilled water. Alkaline copper reagent was added and all the tubes were boiled for exactly 20 minutes in a water bath. After cooling, 1.0 ml. of arsenomolybdate colour developing reagent was added and the mixture was diluted to 25.0 ml. with distilled water. A blank with distilled water was similarly prepared and the instrument was set to zero with it. Controls for the autolysis of the enzyme and hydrolysis of the substrate accompanied the experiments and the optical density of these was subtracted from the experimental readings. The intensity of colour developed in all the tubes was measured in an EEL photoelectric colorimeter at 540mμ.

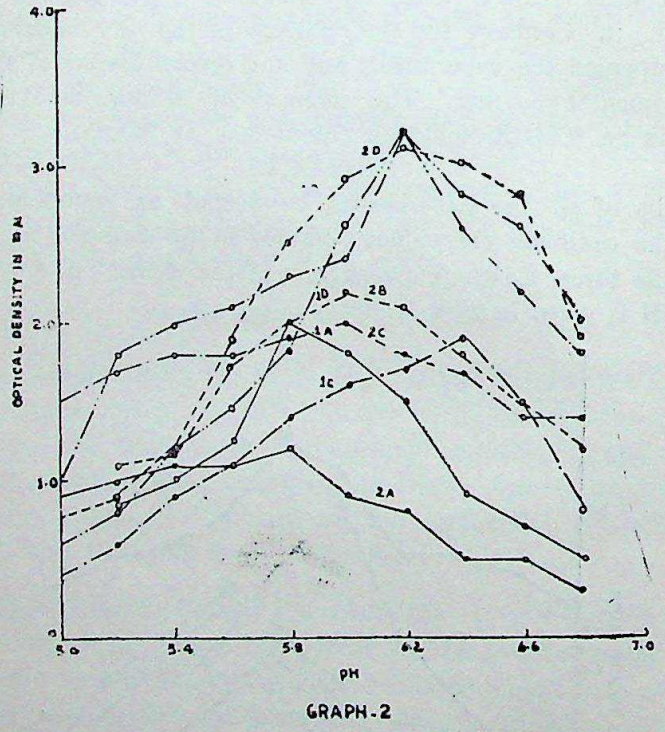
RESULTS

The results of all the experiments conducted are represented in graphs 1-3. Table I gives the optimum *p*H values obtained in the different regions of the alimentary canal of the three fishes. A comparison of the activity of amylase and sucrase at the optimum *p*H is given in table II.



GRAPH 1

Clarias batrachus : optimum *p*H for the activity of amylase and sucrase
Curve 1—amylase Curve 2—sucrase
A—stomach B—intestine
C—liver D—pancreas



GRAPH-2

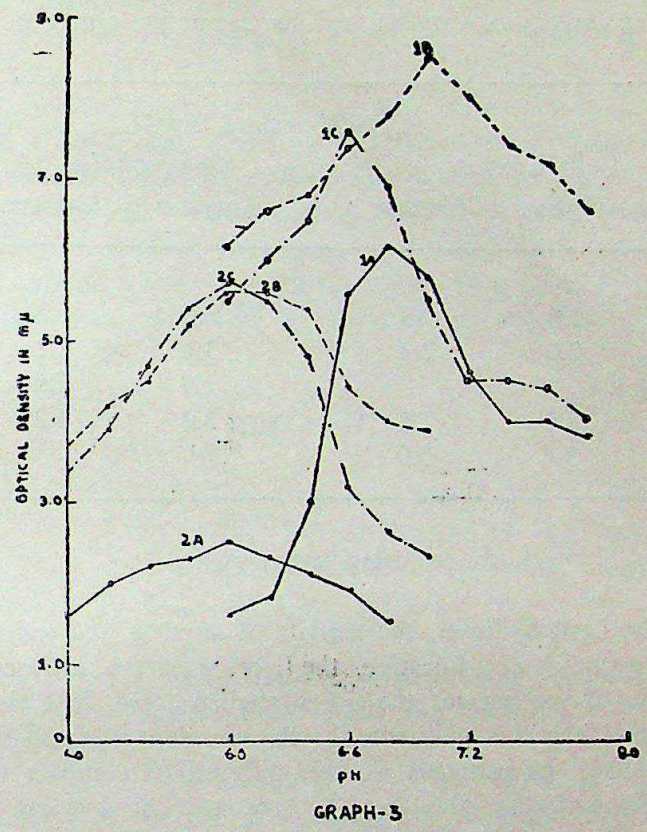
GRAPH 2

Ophicephalus punctatus : optimum *p*H for the activity of amylase and sucrase

Curve 1—amylase Curve 2—sucrase

A—stomach B—intestine

C—pyloric caeca D—hepatopancreas



GRAPH 3

Cirrhinus reba : optimum *p*H for the activity of amplase and sucrase
Curve 1—amylase Curve 2—sucrase
A—intestinal bulb B—intestine
C—hepatopancreas

TABLE I

Showing the *p*H optima for the activity of carbohydrases

Origin of the extract	*Optimum p*H *in* *Clarias* Amylase	*Clarias* Sucrase	*Ophicephalns* Amylase	*Ophicephalns* Sucrase	*Cirrhinus* Amplase	*Cirrhinus* Sucrase
Stomach or Intestinal bulb	5.6	5.8-6.0	5.8	5.8	6.0	6.0
Intestine	6.4	6.2	6.2	6.0	6.0-6.2	6.0-6.2
Pyloric caeca			6.4	5.8-6.0		
Hepatopancreas	6.2	6·0	6.2	6.2	6.0	6.0
Pancreas	6.0	5.8				

TABLE II

Showing the activity of amylase and sucrase at the optimum *p*H

Origin of extract	*Optical density in mU*					
	Clarias		*Ophicephalus*		*Cirrhinus*	
	Amylase	Sucrase	Amylase	Sucrase	Amylase	Sucrase
Stomach or Intestinal bulb	1.0	0.8	2.0	1.2	6.2	2.5
Intestine	2.0	2.3	3.1	2.2	8.5	5.6
Pyloric caeca			1.9	2.0		
Hepatopancreas	2.4	2.1	3.2	3.2	7.6	5.7
Pancreas	3.4	3.0				

DISCUSSION

Among the carbohydrases, the activity of amylase and sucrase has been studied. Stomach or intestinal bulb, intestine, the liver with the diffused pancreas in it are the main source of amylase in the fishes studied here. In *Clarias*, the pancres is a compact gland and it is the main seat for the secretion of these two enzymes. According to Chesley (1934) the pancreas whether diffused or compact is the main centre of enzyme production including amylase. The presence of amylase in pancreas has also been reported by Oya *et al* (1927) in *Anguilla japonica* and by Vonk (1927 and 1941) in the carp and *Lota*. Barrington (1957) concludes "it seems clear that amylase certainly is produced in the pancreas of teleosts". Regarding the role played by the intestine in the secretion of carbohydrases, there is a difference of opinion. According to Babkin and Bowie (1928), Chesley (1934) and Al-Hussaini (1949), amylase is produced by the intestinal mucosa proper, while Vonk (1927) maintains that intestinal mucosa adsorbs the enzyme produced elsewhere in the body. However, in *Clarias* the amylase activity in the intestine cannot be attributed either due to the co-antamination of the pancreatic tissue or to adsorption of the enzyme secreted by the pancreas, as the pancreatic tissue does not extend up to the intestine. Gohar and Latif (1960) have expressed similar opinion about the intestinal amylase in scarid and labrid fishes.

The optimum *p*H for the activity of amylase and sucase lies in the neighbourhood of 5 to 6. According to Gohar and Latif (1960) for scarid and labrid fishes the optimum *p*H for amylase ranges between 5.76 to 6.73, which is well within the range of the present observations. However, Bayliss (1935) has recorded slightly alkaline *p*H for *Pleuronectes*. In conclusion, it may be said that the optimum *p*H for a given carbohydrase varies from portion to portion within the same fish and also from species to species.

According to Al-Hussaini (1949), the concentration of carbohydrases is highest in the predominently herbivorous fishes and lowest in the carnivorous fishes. A similar relation between the food and the coucentration of carbohydrases has been reported by Kenyon (1925) and Vonk (1941). The present observations support this view, as, the concentration of the carbohydrases is highest in the herbivorous fish, *Cirrhinus* while it is much lower in *Clarias* and *Ophicephalus*. According to Kitamikado and Tachino (1961), the amylase activity in the digestive tract of rainbow trout is less than in the carp but more than in the eel, a fact which can be correlated to their feeding habits. Recently, Ushiyama *et. al.* (1966) have given the comparative activity of amylase in the pyloric caeca of salmon where it is about 1/411 that of the intestine of carp, 1/29.5 of pyloric caeca of cod and 1/95 of intestine of flounder.

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A STUDY OF THE PISCICIDAL PROPERTIES OF *ACORUS CALAMUS* L.

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Chopra *et al.*, (1949) have reported near about a hundred plants which are piscicidal in their action. Majority of these are known to possess insecticidal properties as well. Beside these, there are other plants which are recognised only as insecticides. The authors feel that, if tested, some of these may turn out as promising piscicides. Taking this into consideration a work has been undertaken in this department to evaluate some locally available such plants for their fish killing property. The present paper deals with *Acorus calamus L.*

MATERIAL AND METHODS :—

Acorus calamus L. is a very common plant which grows near the fish dwelling localities of Doon Valley. It was collected from Mothranwal and then dried in the Sun after thorough washing. Different parts of the plant i. e., root, rhizome, leaves and fruits were powdered and stored separately in wax sealed bottles.

All fishes were collected from river Chhoti Saung at Gular Ghati, except *Mystus vittatus* Bl., which was not available there and, therefore, it was collected from river Dulahni at Nakraunda. They were brought to the Laboratory in large tin containers. Here all the fishes were treated with 1% solution of NaCl and 1%solution of $KMno_4$ for one minute each, before stocking them in large cement tanks.

The bioassay work has been done on the lines suggested by Doudoroff *et al.*, (1951), alongwith suggestions made by Henderson (1960) and Lennon and Walker (1964). Fishes were acclimatised to the laboratory conditions for ten days, followed by a period of starvation, ranging from 24-36 hours, before their use in the bioassay experiments. Five to ten fishes were used to test each dose. Large rounded glass jars of 10 litre capacity with 6 litre of ordinary tap water, were used as test vessels and test medium respectively. Stock solution, prepared by dissolving 10 g. of the plant powder in distilled water and raising its volume to 1000.o cc., was used to get any required concentration. One ml. of this stock solution in 1 lite of bioassay water produces a concentration of 10 ppm The suitable amount was added to produce any desirable concentration. *p*H of the water and the bioassay medium were noticed regularly. All the experiments were conducted at room temperature which ranged from 28-31°C throughout the investigation.

The experimental work is divided into three parts. In first part, all parts of the plant have been tested on *Puntlus ticto* Ham. In second part, LD_{50}, LD_{100} and minimum lethal dose of most toxic part of the plant have been worked out for *P. ticto*. In third part, the same part of the plant has been used to work out the relative tolerance of some local fishes. Each experiment was replicated. The observations are recorded in Table I, II, III and IV.

OBSERVATIONS AND RESULTS :

1. Toxicity of different parts of *A. calamns* to *P. ticto* :

Only one dose of 500.0 ppm was tested. Rhizome killed the fish much earlier than the other parts of the plant. (Table I).

2. Toxicity of *Acorus* rhizome to *P. ticto* :

Starting from 400.00 ppm and gradually descending to 80.0 ppm doses were tested on *P. ticto*. Average death time has been calculated, by noticing the death time for every fish, for doses causing a 100% morlality in the test fishes within 12 hours. For other concentrations only the percentage of mortality at the end of 12, 24 and 48 hours period was noticed. (Table II). LD_{100} minimum lethal dose and LD_{50} (calculated by the two methods) are listed in Table III. The toxicity curves of Acorus rhizome for P. ticto drawn by the two methods are given in Fig. I & II.

3. Tolerance power of different fishes to *Acorus* rhizome :

From the persual of Table IV it is evident that tolerance power of different fishes varies from sprcies to species.

P. ticto Ham, Bhitti, *Barilius bendelisis* Day, Chilva, *Garra lamta* Ham. 'Golla', *Nemacheilus rupicola* Ham. 'Gadvriya' and *Tor puttitora* Ham. 'Mahaseer' are among the most succeptible fishes, having the same tolerance power. *Rasbora daniconius* Ham., *Mystus vittatus* Bl. 'Tengra' and *Channa gachua* Ham., 'Dolla' are the most hardy species among those tested in the present study. *Danio devario* Ham., 'Paisa Machali' possesses the intermediate position among the above two categories of tolerance.

4. Response of the test fish to rhizome :

a. Addition of the rhizome power into water, holding the test fish, is marked by a momentary excitation, after which a long period of quiescency is observed.

b. Quiescency is accompanied by a gradual retardation in the rate of opercular movement of fish.

c. A very slow swimming breaks this quiescency and the fish strives to surface of water, where it swims backwards.

d. Body becomes inverted and the fish remains flaating on the surface for some time and then finally, settles down at the bottom of container.

e. Fish is almost completely anaesthetised, as it does not exhibit any response towards stimuli of exterior movement, sound and touch.

f. The moribundity is visualized by the absence of any motion and respiration (No movement of operculum). Mouth and operculum remain distended. If the fishes at this stagae were transferred immediately to fresh water, they showed a complete recovery within a short time.

CONCLUSION :

1. Rhizome of *A. calamus* is the most toxic part.

2. LD_{100} LD_{50} and minimum lethal dose of Acorus rhizome for *P. ticto* for 12, 24 and 48 hours has been worked out.

3. 125.0 ppm concentration of *Acorus* rhizome eradicates all the species except *R. daniconius*, *M. vittatus* and *C. Gachua* for which a dose of 250 ppm was required.

4. Though *Acorus* rhizome is not as toxic as Derris root (Leonard, 1939) and Randia fruit (Natarajan, 1965), yet it can prove a good and safe fish poison because of its availability in plenty. Further, it may also be useful in anesthetising the fish. More work is being carried out in this department.

ACKNOWLEDGEMENTS :

The authors owe their gratitude to Dr. Robert E. Lennon, Director, Fish Control Lobortary, Wisconsin, U. S. A., for his valuable suggestions for giving the present shape to this paper. We are thankful, also, to the Principal, D.A.V. Post-graduate College, Dehradun, for the facilities given.

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Note : paper mark with +, was not consulted directly.

TABLE (I)—**RELATIVE** TOXICITY OF DIFFERENT PARTS OF **A. CLAMUS** TO **P. TICTO**

1. Name of the part.	Rhizome	Leaf	Fruit	Root	Control.
2. Dose in ppm.	500	500	500	500	—
3. Number of fish used	10	50	10	10	**10**
4. Range of temperature in °C.	28-31	28-31	28-31	28-31	**28-31**
5. Range of length in mm.	60-64	53-60	57-60	55-59	54-63
6. Average length in mm.	60.0	56.0	61.3	56.9	59.2
7. Range of survival time mnts.	80-240	363-455	433-501	500-557	—
8. Average survival time in mnts.	170.9	409.0	473.5	542.0	—
9. Respones of fish to poison	Erratic	Quiescent	Normal	Erratic	Normal.

TABLE (II)—TOXICITY OF **ACORUS** RHIZOME TO **P. TICTO**

S. N.	Dose (ppm)	No.of Fish tested.	Temp (°C)	*p*H	LENGTH (in mm) Range	Average	SURVIVAL TIME in mnts. Range	Average	ALIVE/DEAD (at hrs) 12	24	48	PERCENTAGE OF DEAD 12	24	48
1.	400	5	28-31	8.5	45-62	51.6	96-200	137.0	5/5	5/5	5/5	100	100	100
2.	300	5	28-31	8.5	53-62	57.6	125-270	208.1	5/5	5/5	5/5	100	100	100
3.	200	,,	,,	,,	47-59	52.3	295-655	425.6	,,	,,	,,	,,	,,	,,
4.	170	,,	,,	,,	46-49	48.5	245-525	423.0						,,
5.	150	,,	,,	,,	42-50	47.5	183-670	506.0	,,	,,	,,	,,	,,	,,
6.	125	,,	,,	,,	42-49	46.3	290--	—	3/5	,,	,,	60	,,	,,
7.	122	,,	,,	,,	43-63	52.2	540-	—	—	4/5	,,	40	80	,,
8.	115	,,	,,	,,	47-53	48.6	—	—	1/5	3/5	4/5	20	60	80
9.	110	,,	,,		43-55	47.8	—	—	0/5	2/5	,,	00	40	
10.	105	,,		,,	34-54	47.6	—	—	,,	,,	,,	,,	,,	,,
11.	100	,,	,,	,,	32-59	48.0	—	—	,,	,,	,,	,,	,,	,,
12.	95	,,	,,	,,	47-55	51.0	—	—	,,	,,	3/5	,,	,,	50
13.	90	5	,,	,,	39-55	55.5	—	—	,,	1/5	2/5	,,	20	40
14.	80	5	,,	,,	40-55	44.5	—	—	,,	0/5	0/5	,,	00	00

TABLE (III)—THE VARIOUS DOSES OF ACORUS RHIZOME FOR P. TICTO.

S. No.	Name of the Dose	FOR HOURS 12	24	48
1.	LD100	150 ppm	125 ppm	120 ppm
2.	LD50 (Litchfield & Wilcoxon)	122.5 ppm	108 ppm	93 ppm.
3.	LD50 (Bliss)	122.5 ppm	110 ppm	95 ppm.
4.	Minimum Lethal dose	110 ppm	80 ppm	80 ppm.

TABLE (IV)—EFFECT OF A. CALAMUS RHIZOME ON DIFFERENT FISHES AT DIFFERENT DOSES.

S. No.	Name of Fish.	Dose (ppm)	Temp (°C)	No.of fishes	LENGTH in mm Range	LENGTH in mm Average	SURVIVAL TIME in mnts. Range	SURVIVAL TIME in mnts. Average	REMARKS
1.	**Puntius ticto**	125	28-31	5	44-57	49.3	310-335	320	—
		250	,,	,,	62-67	63.0	225-304	256	—
		Control	,,	,,	46-61	52.0	—	—	—
2.	**Barilius bendelisis**	125	,,	,,	76-86	82.0	300-351	324	5th fish died in 145 mnts.
		250	,,	,,	82-90	87.0	245-400	326	—
		Control	,,	,,	83-89	86.0	—	—	—
3.	**Discognathus (Garra) Iamta.**	125	,,	,,	81-99	86.0	305-360	325	—
		250	,,	,,	70-78	73.0	185-200	195	—
		Control	,,	,,	80-88	85.0	—	—	—

4. **Nemacheilus rupicola**	125	„	„	50-57	53.0	330-345	340	—
	Control	„	4	48-53	50.0	—	—	—
5. **Tor putitora**	125	„	5	80-85	83.3	350-363	356	—
	Control	„	„	80-83	81.0	—	—	—
6. **Danio devario**	125	„	„	62-67	65.0	—	—	All died in 96 hrs.
	Control	„	„	63-72	67.0	—	—	—
7. **Rasbora daniconius**	125	„	„	81-89	84.0	—	—	No mortality.
	250	„	„	73-75	74.3	—	—	All died in 96 hrs.
	Control	„	„	77-90	84.0	—	—	No mortality.
8. **Mystus vittatus**	125	„	„	88-87	84.0	—	—	—do—
	250	„	„	75-86	78.5	—	—	All died in 96 hrs.
	Control	„	2	77-83	79.0	—	—	—
9. **Channa gachua**	250	„	5	71-76	73.0	—	—	All died in 96 hrs.
	Control	„	„	70-83	80.0	—	—	—

STUDIES ON THE MORPHOLOGY OF THE ALIMENTARY CANAL OF NAJA NAJA NAJA (LINN).

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The alimentary canal is closely related to the habits, habitat, and feeding habits of the animals. The study of it has been much neglected in snakes. The alimentary canal of *Typhlops*, however, has been studied by Robb (1960), but still there is a great deal to be known about the morphology of alimentary canal of snakes. The study of the alimentary canal of *Naja naja naja* (Linn.) has been undertaken in an endeavour to increase the knowledge of the feeding habits and modifications in the different parts of the alimentary canal of this group of reptiles.

METHODS AND TECHNIQUE

For the study of the alimentary canal, the specimens were collected from the forests of North Shivalik range with the help of snake-charmers. These were chloroformed and dissected fresh to study the position and size of the different parts of the alimentary canal. Morphology of the buccal cavity, however, was studied after preservation of the head in 5% formalin for about a month.

For histology, different parts of the alimentary canal were fixed in Bouin's fluid and sectioned at 8 to 10 μ. Triple Mallory's stain gave the best staining results. Microscopic sketches have been made with the help of camera lucida. The measurements given in the description are of a snake which measured 155.00 cms. in length from head to tail.

MOUTH AND BUCCAL CAVITY

The mouth opens in the buccal cavity. The gape of the mouth is very large. Two functional fangs, attached to the maxilla, are present one on either side. One reserve fang remains present behind each functional fang which becomes active when the functional fang is broken. Palatine, pterygoid, and mandible possess small curved teeth.

In the dorsal region of the buccal cavity, very small paired openings of internal nares are present. They remain hidden by palatal folds. Slightly posterior to these are seen the choanal fossae. Eustachian recesses are absent.

The tongue is long, thin, flexible and is deeply forked at its free end. The groove between the two portions extends upto the point where the tongue enters into its sheath. A little behind the tongue is the larynx, forming a slight prominance on the floor of the mouth cavity. The glottis is situated centrally on the surface of the prominance.

OESOPHAGUS

Under the present investigations it has been found that the oesophagus, which lies in the left dorsolateral aspects of the body cavity, extends approximately for half the length of the gut. It is thin-walled, soft, and strap like. It is slightly wider at the anterior end than at the posterior end. The longitudinal folds on its internal surface are visible externally. Towards the posterior limits the wall of the oesophagus becomes gradually firmer and more opaque, making the identification of the oesophagus and stomach very difficult, though internally the identification is obvious to the naked eye.

STOMACH

The stomach consists of two regions, the anterior cardiac region and the posterior pyloric region. There is a slight variation between the two, though again the exact line of demarcation is not clear. The cardiac is somewhat wider than the pyloric region, and the wall of the latter is more muscular.

PYLORIC SPHINCTER

The position of the pyloric sphincter or the duodenal region is marked by a very deep but very narrow, constriction. The alimentary canal after this constriction is quite narrow. The length of the duodenum is 2.80 cms. in a snake of 155.00 cms.

INTESTINE

Immediately behind the pyloric sphincter the alimentary canal widens out suddenly and it remains convoluted up to 20.00 cms., though at no stage it could be described as coiled.

COLON

Towards the end of the small intestine the convolutions diminish, though they do not disappear entirely until a short distance in front of the rectum. This region between the intestine and rectum is colon region. Again, the dividing line between the small intestine and the colon is not visible externally. The colon is short and slightly distended.

RECTUM

The colon leads to the rectum. The rectum is much distended in this snake. It bears a thin membranous wall and opens into the cloaca.

The following table gives the length of the various regions of the alimentary canal of a specimen of *Naja naja*, which measured 155.00 cms. from head to tail.

Region	Length in cms.	Length expressed as percentage of total length of alimentary canal.
Oesophagus	53.00 cms.	38.05%
Stomach	36.00 cms.	25.84%
Pyloric sphincter	2.80 cms.	2.01%
Intestine	20.00 cms.	14.36%
Colon	9.50 cms.	6.82%
Rectum	18.00 cms.	12.92%

It is quite evident from the above table that the stomach region is quite lon , o give sufficient time for reaction of gastric juice to the food; and as the food consists of a complete living animal, swallowed as a whole, the faecal matter is too much and the rectum is thus quite longer.

Internally and histologically, the alimentary canal shows a good degree of differentiation between the various regions than is discernable externally.

The wall of the oesophagus is very simple. The mucosa is composed of columnar cells. The muscularis mucosis is absent. The submucosa is only developed to an appreciable extent in the cavities of the folds of the lining membrane. However, in the posterior region of the oesophagus the submcosa is slightly more vascular than in the anterior oesophageal wall. Circular and longitudinal muscle fibres are poorly developed.

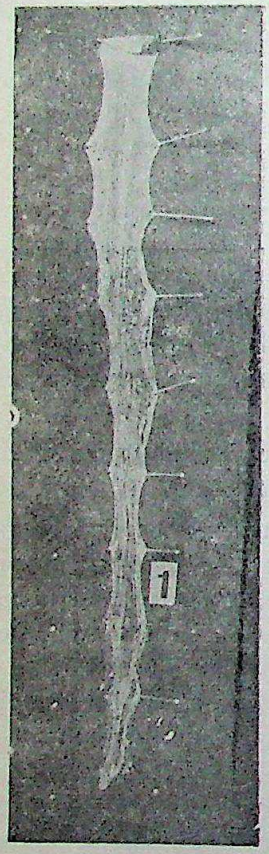
The junction of the oesophagus and stomach is clearly seen internally as a slight irregular line formed by the ending of the oesophageal folds and begining of maze--like foldings of the mucous membrane lining the cardiac stomach. These folds are very deep, irregular and branched and enormously increase the surface area of the gut. In the cardiac region gastric glands are smaller and more scattered than in the pyloric stomach. Muscularis mucosis is wide in the stomach and circular muscle fibres are enromously developed.

The pyloric sphincter is well developed and leaves only a very narrow aperture between the stomach and intestine. The pylorus is relatively wide, ridged band of muscle tissue and opens in the intestine.

Immediately after the pyloric sphincter the gut widens considerably, and the lining is thrown into a dense mass of villi which are flattened and irregular. There are no obvious glands in the intestinal mucosa, and the villi are lined with very narrow colunmar cells. The submucosa, however is well developed. The circular muscle fibres are greatly reduced in width. The longitudinal muscle fibres are present in a continuous band outside the circular muscle fibres.

The junction of the small intestine and colon is assumed to be indicated by the absence of the villi. The wall of the colon is very thin and the submucosa decreases in width.

The wall of the rectum is thin, smooth, and membranus.



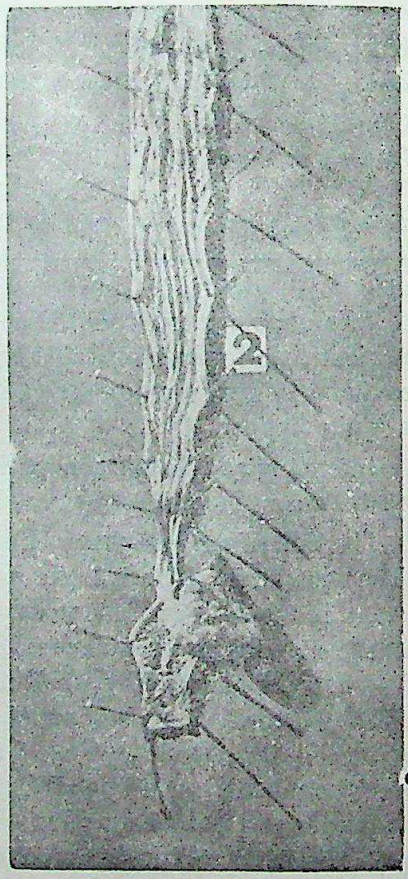
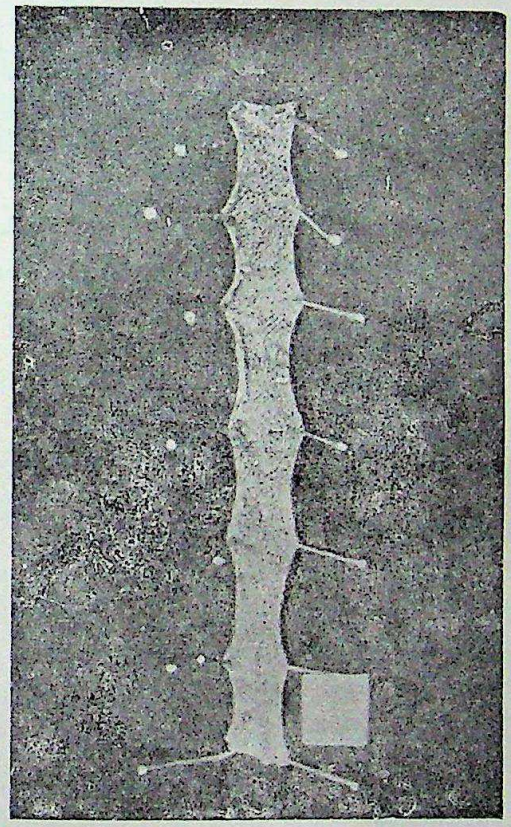


Plate 1. Internal lining of oesophagus, showing longitudinal folds.

Plate 2. Internal lining of stomach (upper), pyloric sphincter (middle), and intestine (lower). Gall bladder, pancreas, and spleen also shown, near the posterior end of the pyloric sphincter (right side).



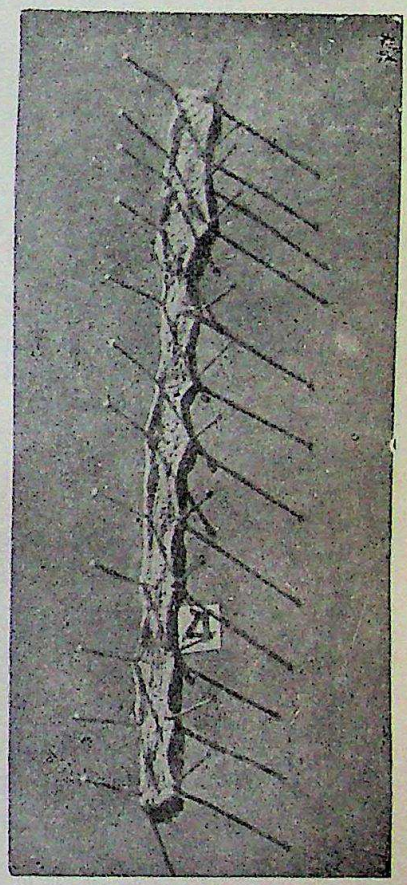


Plate 3. Internal lining of intestine, showing flattened and irregular villi.

Plate 4. Internal lining of intestine (posterior region), showing gradual change (anterio-posteriorly) in structure from villi to ridging.

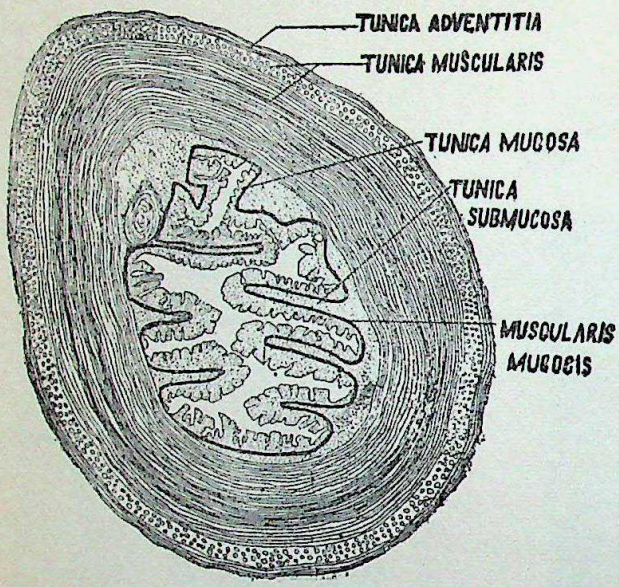


Fig. 1

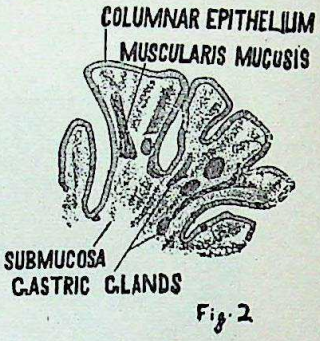


Fig. 2

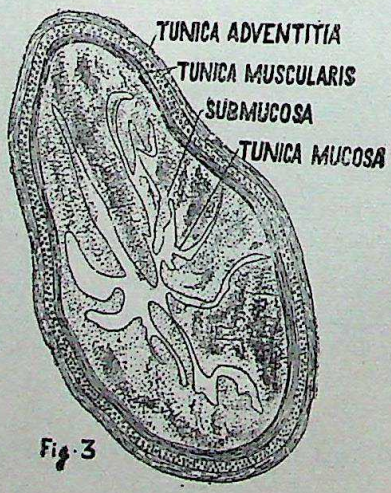


Fig. 3

Fig. 1. T. S. of stomach of *Naja naja naja* (Linn.)

Fig. 2. A part of the gastric villus. of *Naja naja naja* (Linn.)

Fig. 3. T. S. of oesophagus of *Naja naja naja* (Linn.).

LIVER

The liver of *Naja naja* is a very elongated structure. It is 34.00 cms. long in a specimen of 155.00 cms. It lies on the right side of the body cavity. It occupies more than half the width of the body cavity. The anterior end of liver is 38.00 cms. away from the tip of the snout. It is reddish brown in colour, and firm in touch.

The liver is not divided into lobes. The anterior and posterior ends of the organ are drawn into quite pronounced points. The postcaval vein is set in a groove along the ventral surface of the liver. It is clearly visible along the whole of the length of liver.

The hepatic duct, leaving the posterior end of the liver passes backward in the body cavity in association with the hepatic portal vein and postcaval vein. It unites with the cystic duct of the gall bladder.

The cystic duct arises from the gall bladder at a point approximately one third of its length from the posterior end and enters the pyloric sphincter at its posterior end on the ventral side.

GALL BLADDER, PANCREAS AND SPLEEN

The gall bladder is egg--shaped in *Naja naja* and is bound to the pancreas and spleen; these three structures lie across the ventral wall of the pyloric sphincter near its posterior end and therefore obscure the latter.

As the gall bladder is situated at a little distance behind the posterior tip of the liver, the hepatic duct is relatively a longer structure.

The pancreas lies on the right side of the gall bladder, closely bound to it. It is a white compact organ divided into many lobes lying side by side. It is approximately 2.50 cms. in size.

The spleen is pale cream, only slightly darker than the pancreas. It is bean--shaped structure, immediately anterior to the pancreas, and very closely bound to it.

SUMMARY

Alimentary canal of *Naja naja* is a straight tube, with slight convolutions in the intestinal region. Externally it is very difficult to distinguish the limits of the various regions of the alimentary canal, while internally most of the regions are distinctly marked off from each other by various obvious changes in the mucous membrane. Tongue is long, thin, very flexible and is deeply forked at its free end. Oesophagus extends for approximately half the length of the gut. Stomach consists of anterior cardiac and posterior pyloric region. Pyloric sphincter is a very narrow and small constriction after the stomach. Intestine is usually thrown into some degree of convolutions.

Liver is elongated structure, pointed at both ends. It is not divided into lobes. Gall bladder is situated some distance behind the posterior tip of the liver. The hepatic duct is relatively longer. Pancreas is divided into many lobes lying side by side. Spleen is a beans--haped structure, and is closely bound to the pancreas.

CONCLUSION

The study of the alimentary canal of *Naja naja* brings about several important conclusions. *Naja naja* is carnivorous and feeds on the small living animals. The gape of the mouth is wide to engulf the complete living animal. The fangs are present at the anterior end of the buccal cavity so as to paralyse the living food before it is engulfed. The teeth present on the palatine, pterygoid and mandible are curved backward to prevent the escape of paralysed food. Glottis separates the digestive passage from the respiratory passage.

Oesophagus is very extensive and so the stomach comes to lie posterior to the liver and heart. Thus during the process of digestion of food, the liver and heart are not disturbed. The large size of the rectum indicates the large quantity of faecal matter.

As the gall bladder is present at a large distance from the liver, the bile duct is longer. Liver is large to ensure ample supply of bile juice.

ACKNOWLEDGEMENTS

The authors are indebted to Dr. C. S. Gupta, Head of the Zoology deptt., Gurukul Kangri Vishwavidyalaya, Hardwar, to Principal, College of Science, Gurukul Kangri Vishwavidyalaya, Hardwar, and to the Principal, D. A. V. College, Dehradun, for providing necessary facilities for work.

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STUDIES ON THE REPRODUCTIVE SYSTEM OF HISTER MAINDRONII LEWIS (Coleoptera-Histeridae)

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INTRODUCTION

The reproductive system in Coleoptera has been worked out by various authors. Important among them are Demandt (1912), Sharp and Muir (1912), Wilson (1926), Tanner (1927), Metcalfe (1933), Kaston (1936), Bissel (1937) and Rakshpal (1946). *Hister maindronii* Lewis been observed feeding upon maggots which live and subsist on the dung of cows and buffaloes. The alimentary canal of H. *maindronii* has been worked out by Sakesna and Verma (1966) but no attempt has so far been made to study the reproductive eystem of this species. In the present paper a detailed study of its male and female reproductive system is presented.

MATERIAL AND METHODS

The adult males and females, both living and freshly preserved, were dissected in normal saline solution under a stereoscopic binocular microscope. The dissected material has been fixed both in Bouin's and Zenker's fluid, but the latter given more satisfactory results. Microtome Sections varying from 5μ to 10μ were cut, and usual method for dehydration, staining and mounting was followed. The drawings were made with the help of camera lucida.

OBSERVATIONS

Male Reproductive organs:

The male reproductive organs are confined to the last three abdominal segments. They lie on either ventro-lateral side of the alimentary canal. The male reproductive organs consist of a pair of white shinning and conspicuous testes, a pair of vasa deferentia, a pair of vesicula seminales, a pair of accessory glands, an unpaired ductus ejaculatorius or ejaculatory duct and the external opening, the male gonopore.

The *testes* about 4 mm. in length, lie closely coiled in the form of a watch spring in the fourth and fifth abdominal segments. Each testis is composed of a large number of testicular follicles (TFL) arranged in three longitudinal rows. Each testis can be divided into two portions viz., an anterior coil and a posterior coil differing in their arrangement of the testicular follicles. The anterior region consist of 10-13 large sessile follicles opening directly into the vas deferens (VD). From the apex of the each anterior coil arises two filamentous structures, one dorsally and the other ventrally. They very much resemble

the accessory glands in morphological and histological details but how far they may be regarded as such is yet to be ascertained. The posterior coil consists of a large number of sessile follicles arranged in three longitudinal rows. Out of the three rows of follicles one is composed of larger follicles, while those of the other two rows are somewhat smaller.

Histologically each testicular follicle consists of sperm cells (SC) arranged peripherally. Sperms (SP) are developed from the sperm cells and are shed into the cavity which opens into the vasdeferens by a very minute openings.

The *vasa deferentia* (VD) are the paired canals leading back from the testes. These canals run on the inner side of the testes extending posteriorly and are of uniform diameter. The two vasa deferentia meet posteriorly to form the common ejaculatory duct. Immediately before the fusion they swell up slightly and form the vesicula seminales (VS).

Histologically the vas deferens consists of an outer peritoneal sheath, a middle coat of muscular fibres and an inner layer of epithelial cells.

The *vesicula seminales* (VS) are differentiated from the vasa deferentia only by slight dilation. Their principal function appears to be the storage of mature sperms as the latter leaves the testes.

The *ductus ejaculatorius* (DEJ) is a highly muscular tube formed by the confluence of the vasa deferentia posteriorly. The walls of the ejaculatory duct are provided with a powerful muscular coat. The external aperture of the ejaculatory duct or male gonopore (GP) is situated on an intromittent organ, the phallus.

In *H. maindronii* a single pair of accessory glands (AG) originate from the anterior end of the ejaculatory duct. Each gland consists of four long tubular processes which unite to form a common canal opening into the ejaculatory duct. They lie closely adhered to the wall of the abdomen in the last segment.

Female Reproductive organs

The female reproductive organs lie dorso-laterally over the alimentary canal and are confined almost to the same segments as occupied by the male organs. The female reproductive organs consist of a pair of ovaries, a pair of lateral ducts converging posteriorly, an unpaired median oviductus communis, a sac like paired receptacula seminis and a female gonopore opening to the exterior.

Each ovary consists of four tapering cylindrical tubes, the ovarioles (OV) all converging anteriorly. The apex of each ovariole consists of thread like filament, the suspensory ligament (SL). All the ovarioles of one side are connected at their tips by the suspensory ligaments and form a common ligament. The common ligaments of both the ovaries again unite and form a median suspensory ligament (MSL). The median suspensory ligaments

EXPLANATION OF FIGURES

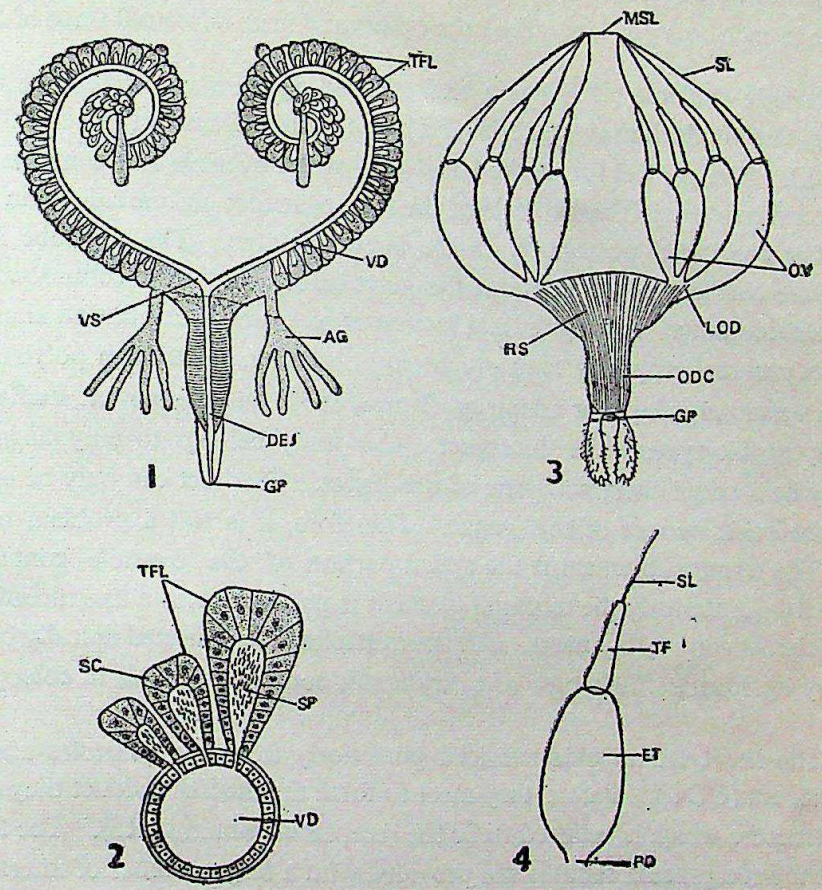

Fig. 1. Male Reproductive organs.

2. T. S. of Vas deferens alongwith testicular follicles.

3. Female reproductive organs.

4. Single ovariole.

is a thin tube. The ovaries lie freely in the body cavity and are not enclosed in any sheath. All the ovarioles do not mature at the same time. The authors have often observed that one ovariole in each ovary as larger than the others and in an advanced stage of development.

A single ovariole (OV) has a flask shaped appearance. It can be divided into pedicel (PD), the vitellarium or egg tube (ET) the terminal filament (TF) and the suspensory ligament (SL). The pedicel forms the basal part of the ovariole and connects the egg tube with the lateral oviduct. The pedicels of the four ovarioles on one side form a short calyx which further continued posteriorly as the lateral oviduct. The egg tube is the longest portion of the ovariole which contains the germ cells. In mature conditions the egg tube swells up considerably. A longitudinal section of an ovariole exhibits an alternating succession of oocytes and trophocytes, a *polytrophic condition*. Although polytrophic ovariole is a characteristic of sub-order adephaga (Imms, 1957) but the present studies reveals that it is a polytrophic type, while the insect under study belongs to polyphaga. It appears that it may be a specific characteristic of this insect. This fact can only be establised after studying the other species of this genus. Therefore, it is still a problem to be explored further. The terminal filament is the apical portion of the ovariole containing a solid mass of cells. Anteriorly the terminal filament is produced into a fine thread like structure known as the suspensory ligament. All the ovarioles are connected apically by means of the suspensory ligaments. This type of ovary is not commonly found in coleoptera.

The short lateral oviducts lead posteriorly from the ovarioles and unite into a median oviduct (ODC). Before they meet to form the median oviduct they dilate to form, sac-like structure which is believed to be the receptacula seminis (RS). The lateral oviducts as well as the receptacula seminis are provided with a large number of internal folds which descend down into the vagina. There are no glands present which open directly into the vagina. The only portion which may be considered to have some space for the mature ova is the dilated portions of the lateral oviduct is called *receptacula seminis* by the authors. It is thrown into a large number of folds internally and it may be possible that after coitus the sperms travel up long the median oviduct and are stored in the receptacula seminis. As soon as the ova descend down from the ovaries they get fertilized here and then the fertilized eggs pass out of the body through the female genital opening.

The *median oviduct* or the *oviductus communis* (ODC) is a straight tube without any loops or coils and is formed by the confluence of two lateral oviducts. It is continued to the posterior most part of the body where it opens by the female gonopore (GP).

ACKNOWLEDGEMENT

Thanks are due to the Principal, Meetut College, Meerut for providing the facilities during the courses of these investigations.

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ABBREVIATIONS

AG — Accessory gland
Dej — Ductus ejaculatorius
ET — Egg tube
GP — Gonopore
LOD — Lateral oviduct
MSL — Median suspensory ligament
ODC — Oviductus communis
OV — Ovariole
PD — Pedicel
RS — Receptacula seminis
SC — Sperm cells
SL — Suspensory ligament
SP — Sperms
TFL — Testicular follicles
TF — Terminal Filament
VD — Vasa deferentia
VS — Vesicula seminales

——o——

THE INSECT FAUNA OF MUZAFFARNAGAR—COLEOPTERA I.

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INTRODUCTION

Inspite of richness of Upper Gangetic plain in its geographical resources, no attempt has so far been made to explore the insect fauna of this belt. The present attempt to study the insect forms of this locality is undertaken in this department with an aim to have the preliminary knowledge of the local insects and to study their distribution in comparision to the well-surveyed Indian regions. It is certain that several species are common to all the places but at the same time there might be a few characteristic of the place. It is also believed that a number of insects in this region are still unreported; therefore, it is proposed to undertake their morpho-taxonomic studies. The present account is mainly based on insects collected with the light-trap operated during August & September 1971 in the college compound.

GEOGRAPHICAL DESCRIPTION OF MUZAFFARNAGAR

Muzaffarnagar is located in the Northern-western belt of Uttar Pradesh, between 29°27′ 20″ N to 29°28′40″ N latitudes, and 77°41′ 15″ E to 77°42′ 35″ E longitudes with a magnetic declination 0° 15′ East (in 1965, decreasing by 2′ annually), and 245 metres above the sea-level. The maximum and minimum temperatures recorded were 35°C. and 26°C. respectively. The average rainfall observed measures about 60 mm.

LIST OF INSECTS—COLEOPTERA*

I. Suborder Adephaga:

Family	**Name of Species**
Cicindelidae	*Cicindela sexpunctata* F.
,,	*C. erudita* Wied.
,,	*C. grammophora* Chaud.
,,	*C. vigintiguttata* Hbst.
,,	*C. undulata* Dej.
Carabidae	*Scarites inconspicuus* Chaud.
,,	*Ophionea indica* Thunb.
,,	*Macrocheilus trimaculatus* Oliv.
,,	*Lesticus politocollis* Motsch.
,,	*Abacetus guttula* Chaud.
,,	*Amara darjeelinensis* Putz.
,,	*Graspedophorus elegans Dej.*
,,	*Coptodera transversa* Goeb.

* Paratypes kept in Department. of Zoology, S. D. College, Muzaffarnagar.

,,	*Callistominus chaleocephalus* Weid.
,,	*Chlaenius duvauceli* Dej.
,,	*C. hamifera* Chaud.
,,	*C. trinotatus* Chaud.
,,	*C. nepalensis* Hope.
,,	*C. malachinus* Motch.
,,	*Brachinus hexagrammus* Chaud.
,,	*B. eucosmus* Andr.
,,	*Tetragonoderus* sp.
Paussidae	*Platyrhopalus angustus* Westw.
Dytiscidae	*Rhantus punctatus* F.
,,	*Hydaticus irttatus* F.
,,	*Eretes stiches* L.
,,	*Gaurodytes biguttatus* Ol.
Hydrophillidae	*Hydrous cashmirensis* Redt.

II. Sub order Polyphaga:

Family	**Name of Species**
Scarabidae	*Apogonia granum* Burm.
,,	*A. carinata* Brsk.
,,	*Brahmina* sp.
,,	*Adoretus lasiopygus* Burm.
,,	*A. limbatus* Bl.
,,	*Mimela passerinii* Hope
,,	*Catharsisus molossus* Linn.
,,	*Onthophagus gazella* (F.)
,,	*O. lapillus* Arrow
,,	*O. orientalis* Has.
,,	*O. pacificus* Lansle.
,,	*Heteronychus lioderes* Redt.
,,	*Onitis philemon* F.
,,	*Balboceras quadrideus* F.
,,	*Aserica* sq.
Elateridae	*Heteroderes albicans* Caud.
,,	*Trachylacon* sp.
,,	*Melanoxanthus* sp.
Tenebrionidae	*Pachyrrhionadoretus frontatus* Burm.
,,	*Gonocephalum* sp.
Chrysomelidae	*Haltica cyanea* (Weber)

Curculionidae	*Myllocerus undecimpustulatus* Fst. var. *maculosus* Desbroches
,,	*M. transmarius* Hbst.
,,	*Tanymecus sciurus* (Ol iv.)
,,	*Lixus* sp.
Coccinellidae	*Oenopia* sp.

ACKNOWLEDGEMENTS

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THE LACERTILIAN--FAUNA OF POONCH VALLEY (J. & K.)

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Some work has already been done on the Ichthyofauna of Poonch valley but no comprehensive report exists on the faunistic survey of the lizards of this valley. The valley of Poonch being geographically isolated, the rocky hilly area is of special interest for lacertilian-fauna. It is situated south-west of Srinagar at a distance of about 70 miles via Loren. It is surrounded on all sides by high mountains which remain snow-capped for a period of about more than six months in a year and elevate their ranges from 3000 to more than 6000 feet. The climate is solubrious like that of Kashmir.

To the best of author's knowledge and belief, in the available literature on the lacertilian-fauna of India there is no specific reference on any comprehensive report on the faunistic survey of the lizards of the Poonch valley. However, all the lizards species recorded in the present paper are being reported here for the first time from Poonch valley.

LIST OF LIZARDS COLLECTED FROM THE POONCH VALLEY

Name and systematic position	*Locality*
I-Family: Geckonidae	
1. *Hemidactylus brooki* (Gray).	Surankot, Mendhar, & Magnar.
2. *Hemidactylus flaviviridis* (Ruppel).	Jhalas, Nangali Sahab.
3. *Stenodactylus orientalis* (Med. Gecko).	Mandi, Gulpur, Surankot.
4. *Ptyodactylus homolopis* (Chinese Gecko).	Kunian, Chandak, Magnar.
5. *Gymnodactylus sp.*	Magnar, Loran, Khanotar.
II-Family: *Agamidae*	
6. *Calotes versicolor* (Daubin).	Mondhar, Surankot, Chandak.
7. *Agama tuberculata* (Head-up lizard).	Poonch Fort, Khakhnaban.
8. *Agama agrorensis himalayana* (Him.lizard)	Bhimbergali, Draba, Nurichhamb
III-Family: *Scincidae*	
9. *Lygosoma himalyana* (Him. Skink).	Shahpur, Doda hill, Sankh hill, Jaranwaligali.
10. *Eumoces scutata* (Chinese Skink).	Gulpur, Krishnaghati.
11. *Mazuya dissimiles*	Mendher, Loran, Mandi.
12. *Lygosoma ladacevse* (Ladakh Skink)	Bufaliaz, Magnar, Loran.

DISCUSSION

In the present survey, various localties of Poonch valley were thoroughly investigated for lacertilian-fauna with the result that 12 species of lizards were collected which have been

recorded in the present contribution. However, some lizards described in the present paper have already been collected and identified from Kashmir region (Das *et al.* 1964). From the comparative survey of the lizards of Poonch valley with that of Kashmir region it is apparent that the lizards have established themselves far better in forms and numbers in the special ecological conditions of Poonch valley.

Das *et. al.* (1964) recorded only 7 species of lizards from Kashmir region giving their Palaearctic origin and distribution in Leh and Ladakh area also. In addition, it is quite obvious that of the three families of lizards, viz. *Geckonidae*, *Scincidae*, *Agamidae*, the first two have their maximum representatives in Poonch valley than family *Agamidae* which has only two species of the genus *Agama* in the Poonch valley and Kashmir region as well.

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PALAEARCTIC ELEMENTS IN THE TICK FAUNA OF KASHMIR (J & K STATE) INDIA.

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A perusal of the voluminous scientific literature on the world ticks reveals that there is no reference on the Palaearctic elements in the tick fauna of Kashmir. However, sketchy reports on some Kashmir ticks, that appeared from time to time in different journals of the world are also quite sparse and scattered.

Das, 1966 (Nature) elaborated an interesting but generalized account of various Palearctic elements in the invertebrate and vertebrate fauna of Kashmir but the ticks were left untouched in the whole account.

The present contribution, therefore, preliminarily attempts to elucidate only a bulk of Palaearctic ticks which have established themselves in the special ecological niches of Kashmir.

Topographically, the famed vale of Kashmir has been described as a saucer-shaped valley. It is situated between latitudes 32.17 degrees and 36.58 degrees north, while the range of longitudes is 73.26 and 80.50 degrees. Exact geographical position of this region on the world map is at north west tip of the Oriental region, abutting against the mid south of Palaearctic region. It is 1560 meters above sea level, with an area running 118.4 Kms. long and 40 Kms. broad. The moutains surround the valley from almost all sides.

On the east the highest mountain peaks are Gwashibrari, 5333.7 meters and Nun-khun 7320 meters above sea level. On the north is the colossal peak of Naga Parvat, 7992.9 meters. On the west and south is the Pantsal range with peaks rising to over 4500 meters demarcating the valley from the Punjab.

The Kashmir region has solubrious climate. The temperature ranges from-5 degree centigrade in winter to 30 degree centigrade in summer; the average annual rainfall in the valley is 68.10 centimeters.

Amongst the scientists who attempted to delineate animals of Palaearctic realm the works of Das (1966), Darlington (1957) Ellerman (1951), Murry (1866), Sclater et Sclater (1866), Wallace (1960) and specifically on the Palaearctic affinity of ticks by Filipova (1957) and Pomerantzev (1948) are noteworthy.

The palaearctic region can be well understood if we draw a line along the north of Sarrah, which will include England, Britan, Europe, U.S.S.R., Siberria, China and Japan. In addition, north Himalaya also forms an important part of this region.

Das (1966) stated that the invertebrate fauna of Kashmir appears to have close link with central Asian and Chinese stocks.

The Palaearctic elements belonging to the family Argasidae (soft ticks) are represented in Kashmir by *Argas* (*Persicargas*) *persicus* (*Oken*); *Argas sp.*, *Argas* (*Carios*) *vespertilionis*

(*Lat.* 1802), *Ornithodoros tholozani*, (*Lab. and Meg.* 1882) and *Ornithodoros lahorensis* Neumann 1908.

In Kashmir both *Argas* (*Periscargas*) *persicus* and *Argas sp.* parasitize poultry and have also been reported from various other countries of palaearctic region. The subgenus *Persicargasis* represented in Asia, Africa and possibly in eastern Europe by several species parasitizing mammals as well as wild birds, and throughout warmer areas of the world by a cosmopolitan parasite of domestic fowl, *Argas* (*P*) *persicus* (Hoogstraal, 1956 page 58-74). New World areas of Palaearctic region from which this tick has been reported include California, Georgia, Maryland, Pennslavania and Paraguay; while the Old World areas include Iran (Neotype) and Persia.

Argas (*Carios*) *vespertilionis* which is essentially a bat tick in Kashmir has also been recorded from Germany, China, U. S. S. R., Central Asia and Turkestan all in Palaearctic region.

Besides, of the two species of *Ornithodoros* genus that occur in Kashmir, *O. tholozani* is found on poultry, sheep, dog, man etc in U. S. S. R., Tehran, Syria, Iraq and Central Asia, while *O. lahorensis* is found on horse, sheep, dog, cattle, man etc. in Asia Minor, U. S. S. R., Iran and Yugoslavia (all in Palaerctic region).

A bulk of Palaearctic elements belonging to family Ixodidae (hard ticks) that appears to have been more established than Argasidae (soft ticks) in the special conditions of Kashmir is given here.

The cattle tick *Boophilus microplus* that parasitizes cow, ox, sheep, goat and buffalo (but only cow, sheep and goat in Kashmir) has been recorded from Japan, Korea and Africa etc. The castor bean tick of Europe, *Ixodes ricinus* has many hosts including badger, sorex, swine, lizard, small mammals, pheasant snakes, elk, horse, cattle, dog, foxes, porcupines, weasels, ox, goats, birds etc. (only dogs in Kashmir) in China, Japan, Turkey, Denmark, Germany, Hungary, Yugoslavia, Bulgaria, Sweden, Finland, Rumania, U. S. S. R. and Siberia etc., all included in Palaearctic region.

The tick *Heamaphysalis bispinosa* which has been found on horse, cattle, deer, badger, dog (but only cow, sheep and goat in Kashmir) has been documented from Japan, Formosa, Korea, China and U. S. S. R.

The cosmopolitan dog tick *Rhipicephalus sanguineus* that attacks horse, camel, sheep, cattle, buffalo, rodent, hedgehog, man (but on dog in Kashmir) has been reported from nearly all countries lying between latitudes 50 degree north and 35 degree south. The *Rhipicephalus turanicus* a considered synonimous of *R. sanguineus* has also been reported from dogs n Kashmir.

In addition, there are many other tick species found in Kashmir region but they all appear to be mostly endemic. The study of Geographical distribution of the animals explicitly bolsters and explains the possibilities of the ingression of the Palaearctic ticks of large mammals due to transportation etc. and small mammals as also brids due to mainly migration.

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